EDISON IN HIS LIBRARY.

THOMAS ALVA EDISON

THE TELEGRAPH-BOY
WHO BECAME A GREAT INVENTOR

BY

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THOMAS ALVA EDISON.

CHAPTER I.

FIRST WORK AS A NEWSBOY.

THOMAS ALVA EDISON, the world's greatest living inventor and electrician, was born at Milan, a dull little canal town in Erie County, Ohio, on the 11th of February 1847. On his father's side he was descended from an excellent family of Dutch millers, who emigrated from Amsterdam to America about the year 1737. They were men who lived long lives—Edison's great-grandfather lived to the age of one hundred and two years, and his grandfather one hundred and three—and from them he inherited the great physical powers of strength and endurance which have marked his wonderful and chequered career. Edison's father, Samuel Edison, was a nurseryman, dealer in grain, in lumber, and in farm lands, and later, a produce merchant.

Edison's mother's maiden name was Nancy Elliot. She was by birth a Scotchwoman, and she had been brought up and educated in Canada. She had a sweet yet strong individuality, and having received a good solid

education in the Canadian High Schools, she became a teacher there, in which capacity she displayed great ability, before marrying Samuel Edison.

It is said that there was a very special love between Mrs Edison and her son Thomas. She loved his very presence, and partly for that reason, and partly because of the poverty which came upon them before long, she kept the boy at home, and, except for two months' schooling, taught him entirely herself. With her he learned not only reading, writing, and arithmetic, but also the great object of learning. For she implanted in his mind a love of learning, a hunger for knowledge, which is the end of all true education. To her young Edison owed the early teaching and training which gave his mind its strong bent towards invention and enterprise. His father, too, was so interested in the boy's education, that, by way of encouraging him to read, whilst reading was for Tom a toilsome and difficult matter, he paid him for every book he perused. Happy boy, to have such parents! Their intelligent sympathy, and the tuition of the mother, caused him to become a great reader, and then practically he took his education into his own hands, and read everything he came across.

An amusing story of his early childhood is given to us on the authority of his only sister. When he was only six years old, he found that a goose belonging to the family was sitting, and, a little later, saw the astonishing result in some goslings. He studied this wonderful occurrence in his little mind. Then one day he was missing. He was sought everywhere, but no one could find him, until at length his father discovered him curled up in a sort of nest he had made for himself in the barn, and filled with goose and hen eggs. He was keeping them as warm as

he could; in fact, the little boy was sitting on the eggs and trying to hatch them!

He was an ingenious little fellow, and, even when he was at play, showed the mechanical turn of his mind by building plank roads, digging caves, and exploring the banks of the canal. But the play had to be soon exchanged for hard work, for, when he was only seven years old, a wide-spread depression in commercial affairs caused his father to become poorer, and in consequence of this he left his picturesque home in Milan, and took his family to live in the town of Port Huron, Michigan. Here the boy was early set to work to earn his own living, but still he devoted every moment he could to the improvement of his mind.

'I'm a bushel of wheat! I weigh eighty pounds,' he said, thoughtfully, to his mother one day when he was only twelve years old. And the observation showed that he had already begun to compare things with each other in an old-fashioned, business-like manner.

Soon after that he became a newsboy on the Grand Trunk Railway running into Detroit. It was a busy life. The American newsboys not only show themselves and their wares at the railway stations, but accompany the trains. In American trains there is an outside passage from one carriage to another, upon which people can walk up and down. As soon as passengers have taken their seats and have comfortably ensconced themselves amongst their wraps and rugs, they naturally begin to wonder with what they shall beguile the tedious time of travelling. Then the newsboy, passing from one carriage to another, stands at their elbow, with his tempting display of papers. Whilst the passenger is reading his newspaper, a little later on, he perhaps feels thirsty, and looking

round, lo! there stands the newsboy again before him, this time with a tray or basket of fruits and sweets, which they call candies. Edison, with his bright smiling face and business manner, made a capital little newsboy.

When talking of these young days of his, he was once asked, 'Were you one of the kind of train-boys who sell figs in boxes with bottoms half an inch thick?'

To which question he replied, with a merry twinkle of his shrewd gray eyes, 'If I recollect right, the bottoms of my boxes were a good inch.'

At the stations at which the train stopped, the young newsboy would spring on the platform, and sell his wares to any one who would buy. He had secured the exclusive right as news-agent upon that line.

At Detroit he obtained access to the Free Library, and was so delighted with the sight of unlimited numbers of books that he conceived the idea of reading the entire library, taking the books as they came. He stuck at nothing, reading straight on, and had actually read through fifteen feet of books before his friends discovered what he was about and checked his proceedings. Amongst the books he read were Burton's *Anatomy of Melancholy;* Gibbon's *Decline and Fall of the Roman Empire;* Hume's *History of England; History of the Reformation;* Ure's *Dictionary of the Sciences;* the *Penny Cyclopædia;* and Newton's *Principia*—which last, however, he could not understand. Like a wise lad, therefore, he inquired of one who did, and a comparatively uneducated man gave him a simple and satisfactory explanation. 'This man,' said Edison afterwards, 'explained the problem to me by the use of very simple language, and without the employment of mathematics. I at once came to the conclusion that Newton could have dispensed his knowledge in a

much wider field had he known less about figures.' This, he went on to say, gave him a distaste for mathematics from which he never recovered.

Meanwhile, his interest in chemistry continued. He managed to become the proud possessor of retorts and other apparatus, and obtaining the use of an old baggage-car, turned it into a laboratory. In this place he spent much of his spare time in experiments which caused him both wonder and delight.

Al, as young Edison was called by his fellow-workers on the railroad, was a good son to his parents, and delighted to take home to them as much of his earnings as possible. He also wanted money with which to buy the chemicals to make his experiments. Having no friends who could assist him pecuniarily, he knew that he must depend upon his own exertions. Early and late, therefore, he worked upon the train, and in the stations, at selling his newspapers. But at first he did not earn much money by it. He had to be very careful that he did not buy more papers than he could sell in his very limited sphere of operations; and yet he could not afford to take too few, as they would have been all sold before reaching the end of the trip. This set the boy thinking. It was plain that, to insure a good sale of newspapers, something must be done to arouse the attention of his little public. The time was favourable for making a sensation. The Civil War between the Northern and Southern States was at its height, and the press was full to overflowing with exciting news. He is clever who knows how to seize an opportunity and make use of it. Edison quickly formed, and proceeded to carry out, a capital plan.

Making a friend of one of the compositors in the *Free*

Press office, he persuaded the man to show him every day a first proof of the most important news article. Then, from a study of its headlines, he soon learned to gauge the value of the news and its selling capacity, so as to be able to form a pretty correct idea of the number of papers he would need. Generally he could only dispose of about two hundred, unless there was any special news from the seat of war, when he found he could sell about three hundred.

One day, the friendly compositor showed him a proof slip containing a huge headline. It was the first report of the battle of Pittsburgh Landing, and it gave the number of killed and wounded as fifty thousand.

Grasping the situation at once, Edison saw that there would be a chance of enormous sales of his newspapers, if only he could get the people along the line acquainted with what had happened. How could he let them know? By what means could he create in them an intense eagerness to get his newspapers? The idea of telegraphing the news before he followed with the papers flashed across his mind.

Instantly running over to a telegraph operator, he made a bargain with him. He was to wire to each of the principal stations on the line, asking the station-master to chalk on the blackboard, upon which was usually notified the times of the departure and arrival of trains, the tidings of the great battle, with its enormous loss of life. In exchange for this favour, young Edison agreed to supply the operator with a *Harper's Weekly*, a *Harper's Monthly*, and a daily evening paper for six months from that date.

This bargain made, and the telegraph operator instructed to do his part immediately, Edison turned to the next point, which was to gain possession of all the papers he

required for his great effort. This was a matter of no small difficulty, for he had very little money, and who was likely to trust a poor lad like him? However, he boldly went to the superintendent of the delivery department, and asked for one thousand copies of the *Free Press*, to be paid for after they were sold.

The request was curtly and promptly refused.

Edison's need was great; he saw a small fortune in prospect if he could but get the papers. At last, therefore, he took courage to go up-stairs to the office of the proprietor of the *Free Press*, Mr Wilbur F. Storey.

'I told him who I was,' said Edison, when he afterwards related the story, 'and that I wanted fifteen hundred copies of the paper on credit. The tall, thin, ascetic-looking man stared at me for a moment, and then scratched a few words on a slip of paper. "Take that down-stairs," he said, "and you will get what you want." And so I did. Then I felt happier than I have ever felt in my life since.'

Taking his fifteen hundred newspapers away in triumph, Edison got three lads to help him to fold them. Then he went to his train with his newspapers, in great delight; and only anxious on one point, and that was whether his friendly telegraph operator had kept his promise.

At Utica, about twelve miles off, where the train stopped first, he usually sold two papers at five cents (twopence halfpenny) each. But now, as the train ran into the station, upon looking eagerly out, he thought he saw an excursion party, for the platform was crowded with people. As soon as they perceived him with some of his newspapers in his hands, they began to gesticulate and shout, and he saw they were clamouring for papers.

Seizing an armful, he jumped out, and very soon sold forty.

The next station was Mount Clemens. Here he thought a riot must be going on, for the platform was crowded with a howling mob. But he soon found that what they wanted was news of the battle of Pittsburgh Landing. Those who had friends or relations fighting there were in a state of the utmost suspense and anxiety. Doubling the price of his newspaper, Edison speedily sold a hundred and fifty copies.

At other stations these scenes were repeated. But the climax was reached when he arrived at Port Huron. The station there was a mile from the town, towards which he at once proceeded with his remaining stock of newspapers. When half-way there, he met a crowd of people hurrying towards the station, and recognised at once that they were wanting newspapers. He therefore raised the price of his newspaper to a quarter of a dollar (about a shilling) a copy, and reaped quite a small fortune. On passing a church where service was going on, the whole congregation turned out, and bid against each other for the precious papers.

'You can understand,' said Edison, long afterwards, 'why it struck me then that the telegraph must be about the best thing going, for it was the telegraphic notices on the bulletin boards that had done the trick. I determined at once to become a telegraph operator. But if it hadn't been for Wilbur F. Storey I should never have fully appreciated the wonders of electrical science.'

Thus it was that the boy's mind, hitherto inclined to chemistry, was turned, in admiration and delight, in the direction in which so many of his great inventions were to lie.

CHAPTER II.

THE YOUNG NEWSPAPER EDITOR.

THE great success of his newspaper enterprises encouraged Edison to make yet another venture. This was nothing less than to start a three-cent (three-halfpence) newspaper of his own, to be called the *Grand Trunk Herald*.

Accordingly he procured a disused set of old type and stereos, which had been in the possession of the *Detroit Free Press*, and, making use of the little knowledge of printing gained by watching what was going on in the works when buying his papers, he began to set up and print his small newspaper in his old luggage-car, which he made his office and workshop. Patiently and perseveringly he worked, until at last he could proudly look upon the newspaper of which he was both editor, printer, and publisher.

The journal was very tiny, only twelve by sixteen inches in size. It was filled with railway gossip, changes, and general information which was likely to be of interest to travellers. The news was contributed by the railway men, who took immense interest in the novel enterprise, and by the observant young editor and his assistants—for, with his extended newspaper-selling business, and his new editorial and publishing duties, young Edison now found himself obliged to employ three or four boys.

'My news,' said Edison, one day, to Mr Lathrop, when speaking of this, the first and last newspaper that was

ever published on a train—'my news was so purely local, that outside the cars and the shops I don't suppose it interested a solitary human being. But I was very proud of my bantling, and looked upon myself as a Simon-pure literary man. My items used to run like this: "John Robinson, baggage-master at James's Creek Station, fell off the platform yesterday and hurt his leg. The boys are sorry for John." Or it might be, "No. 3 Burlington engine has gone into the shed for repairs."'

A *fac-simile* of the small sheet of the little newspaper has been recently published. It is very amusing, and shows how many items can be found, even in such a limited space as a single line of railway, to interest those who travel upon it. And also we perceive the crudity of the young editor's professional powers. One leading article reads as follows:

'PREMIUMS.—We believe that the Grand Trunk Railway give premiums every six months to their engineers who use the least wood and coal running the usual journey. Now, we have rode with Mr E. L. Northrop, one of their engineers, and we do not believe you could fall in with another engineer more careful or attentive to his engine, being the most steady driver that we have ever rode behind (and we consider ourselves some judge, having been railway-riding for over two years constantly), always kind and obliging, and ever at his post. His engine, we understand, does not cost one-fourth for repairs what the other engines do. We would respectfully recommend him to the kindest consideration of the G. T. R. Offices.'

Another leading article is about a clever porter who does the work of two. One item concerns somebody's lost luggage, another the daily stage which meets the train at a particular place. The prices of provisions at some

important town are mentioned. Also anecdotes and epigrams fill up spare columns and odd corners.

The paper became quite popular up and down the line, and reached a circulation of about four hundred. Its fame reached England, and the *Times* gave it a commendatory notice, whilst Robert Stephenson, the great engineer, once ordered a special edition of it for himself.

Money began to flow into the pockets of the boy-editor from this source, and from the increased sale of his *Detroit Free Press* newspapers. He was able to give his parents as much as five hundred dollars in a year. But, alas! this pecuniary prosperity was not to last.

Encouraged by the success of the *Grand Trunk Herald*, Edison, in conjunction with another lad who had worked for the *Port Huron Commercial*, began to publish a larger and finer journal, entitled *Paul Pry*.

This last paper was really superior to the other, but a boyish love of fun caused the young editors to be a little too personal in their remarks about individuals. This provoked animosity, and one day a contributed article in *Paul Pry* so offended a subscriber that, when he met young Edison on the banks of the St Clair River, he picked him up and threw him in. Being a good swimmer, the boy soon got out again, but now he felt heartily tired of such dangerous editorial pursuits, and so the paper, *Paul Pry*, came to an untimely end.

The same year Edison's beloved travelling workshop, the old luggage-car, was taken from him. It happened in this way. One day, when he was hard at work, the jolting of the car, which had no springs, upset a bottle of phosphorus and hurled it violently to the floor, setting fire to the car. In a moment all was in a state of confusion.

It was not difficult to extinguish the flames, but the conductor, who had long been displeased with the horrid smells and terrifying noises which proceeded from Edison's car, thought it a good opportunity for turning him out of the train. In a very short time indeed the poor lad was deposited on the platform, with his type, chemicals, and other property thrown after him. The worst of it was, that the brutal conductor, in his rage, gave him, before he descended, such a severe box on the ear, that the delicate organ of hearing was injured for life by the act: though the finest surgical skill was afterwards employed, it was of no avail.

Left alone and desolate amongst the fragments of his poor belongings, ill dressed and ill fed, poor young Edison stood looking after his beloved laboratory and workshop disappearing in the distance. He felt stunned and miserably disappointed. Was this the end of his joyous labours and successful experiments?

CHAPTER III.

LEARNING THE TELEGRAPH.

YOUNG Edison had too brave a heart to be crushed by his misfortunes, heavy and unmerited as they were; so, presently, picking up what remained to him of his property, he set off towards his home.

He had not lost his place as news-boy, but only the privilege of using the old luggage-car as his laboratory or workshop; and he valued that very much. However, on his arrival at home, his good mother consoled him

immensely, by allowing him the use of the basement, or cellar kitchen, belonging to the house, which he forthwith proceeded to fill with all kinds of rubbish.

Mrs Edison had great faith in her son, and when a neighbour expostulated with her upon allowing him to bring so much rubbish home with him, she calmly replied, 'The world will hear of him yet.' Her faith in him has been splendidly justified by subsequent events.

And now the boy's mind, released from its editorial duties, turned with more longing than ever to the desire of mastering the wonderful art of telegraphy. Besides buying and reading a good work on electricity, in the cellar in which he now worked he began to make experiments, together with his friend James Ward.

The two boys actually set up a line between their homes, made of an ordinary stove-pipe wire, insulated with bottles, and crossed under a busy street by means of an old cable fished up from the bed of a river. A piece of spring brass furnished the key, and the magnets were wound with wire wrapped in old rags.

But what were the boys to do for a current? Their first attempt to make one was by means of a couple of big cats. Attaching a wire to their legs, they rubbed them vigorously at each end of the line. This device, however, proved to be a failure; the cats, as Edison's biographers remark, refused to lend themselves to the pursuits of science, and the test resulted in their running away. But, we are told, 'the experiment was not without success; a tremendous local current and perfect electric arc were produced, but it would not work the line, and was abandoned.'

Undaunted by failures, however, Edison continued making his experiments, and bringing home to his cellar

everything which he fancied might be useful for them. Of money to buy necessary chemicals he had little, but, by denying himself everything but the barest necessaries of life, he found means to buy a number of old instruments and other materials. In his working hours he still went on with his former employment of newspaper-selling on the Port Huron train, running from Port Huron to Detroit, and returning daily, except on Sundays. He was still successful with his newspapers, and made a point of leaving at least one dollar of his day's earnings with his parents before setting off again in the morning.

He was a kind-hearted lad, ever ready to help another, and by this time he had many friends amongst the station-agents, operators, and their families all along the line. At Mount Clemens station, where his train usually stayed about thirty minutes, as it did the freight-work and shunted there, he knew several people very well. The station-master, Mr J. U. Mackenzie, had a nice little boy of about two years and a half old, called Jemmy, and, in the intervals of selling his papers, young Edison would play with the child.

One lovely summer morning, in the year 1862, about half-past ten, an occurrence took place which was of much importance to the ambitious and hard-working newspaper-boy. His train had arrived at Mount Clemens. Letting its passenger and luggage car stand on the north end of the station platform, the pin having been pulled between the luggage and first box car, the train of some twelve or fifteen luggage-cars went forward, and then backing in upon the freight-house siding, took out a box car (containing ten tons of material), and pushed it so that its momentum would enable it to reach the luggage-car without any brakesman controlling it.

It happened that, exactly at that moment, Edison, who had been standing watching the fowls in the station-master's poultry yard, turned round and perceived, to his horror, that little Jemmy Mackenzie was on the main line. The little fellow was playing in the sunshine, and throwing pebbles over his head, quite ignorant of the awful danger he was in from the rapidly approaching car.

Dashing his newspapers to the ground, together with his cap, Edison quickly sprang forward to rescue his little friend, at the risk of his own life.

On came the car, but Edison was just able to throw himself and the child out of its way. They fell together, face downwards, and with such force as to drive the particles of gravel into their flesh, but happily just out of reach of the car as it came up. An eye-witness declared that, if Edison had been a second later, he would have lost a foot or have been killed. Indeed the car struck the heel of his boot. The station-master was in his ticket-office; but, on hearing a shriek, he came out of it in time to see the railway-men carrying the two boys to the platform.

Ah, how grateful the poor father was! He was a poor man, living, as so many railway employees do, above his means, and usually spending his salary before he received it from his paymaster. He had no money to offer the brave rescuer of his little boy, but quickly thought of a way of proving his gratitude.

He could teach the poor newspaper-lad the art of telegraphy, and put him in the way of earning a good salary as a telegraph operator. Much to Edison's delight—for this was just the kind of help that he wanted—he at once proposed to do so.

Edison gratefully accepted the welcome offer. Ah,

how hard he worked now! After plying his business all day, each night, on coming home to Port Huron, he returned on the luggage train to Mount Clemens to learn his new work.

For about ten days this arrangement was carried on very satisfactorily; then Edison did not turn up at Mount Clemens for his telegraph lessons for several days. When he did come, however, he brought with him a complete set of working telegraph instruments, so small that they would not cover an ordinary envelope in size. They were perfect in their way, and had all been made by the boy with his own hands, in the gun-shop of Messrs Fisher & Long in Detroit.

Mrs Mackenzie's brother, Rowland Benner, was also learning telegraphy at the same time, and he and Edison vied with each other in their efforts to excel.

Benner assisted Edison with his first speculation. This was nothing less than to try and work a little private telegraph line between the station and the town. The boys made their telegraph office in a drug store in the town, using the instruments Edison had made, upon a line made of annealed stove-pipe wire, upon the stakes of a rail fence, insulated with common nails.

In dry weather this line worked well enough, but on damp, wet days there was no tick to be heard. The young partners fixed a tariff of twelve and a half cents (about sixpence halfpenny), and, during the first months, they took in the munificent sum of thirty-seven and a half cents (rather more than eighteenpence), after which they found it necessary to close the works, as Edison was then about to take more remunerative work.

Others besides the station-master at Mount Clemens assisted Edison in his telegraphic education, and in three

months he understood the art of telegraphy quite well. He used to frequent the Western Union Telegraphic Office in Port Huron, where he learned much; and it was then that he duplexed the workings on the Grand Trunk Cable between Port Huron and Sarnia. This was considered a very wonderful feat, and was a great convenience to the Grand Trunk Railroad, as it made their business much easier to work. It is not known, however, whether Edison was ever paid for doing this.

Three months he remained at Port Huron, working hard and proving his ability; then the greediness and dishonesty of the Western Union agent so disgusted him that he would work no more for him.

The following incident led to this determination on his part. The Press happened to be all eagerness to obtain an exact account of the Presidential address to Congress. It accordingly offered the Western Union agent sixty dollars if he would obtain it. He set Edison to receive it, promising him a reward of twenty dollars (rather more than four pounds). This was a large sum to the young telegraphist, and he was delighted to think of earning it. What, then, was his dismay when, upon his finishing the work, his chief repudiated the bargain and would not pay the money! Nay, more than that, he would not admit any claim for extra work.

Leaving his service at once, Edison obtained, through the help of his friend Mr Mackenzie, a situation as night telegraph operator on the Grand Trunk Railway, with a salary of twenty-five dollars a month.

Here the work was very hard, for the manager under whom Edison worked was exceedingly exacting. One of his regulations was very irksome to the youth. This was, that during the night, as a precaution against

drowsiness, the operators were required to report the word *six* every half-hour.

Now Edison liked to ramble about Stratford, its neighbourhood, and the railway stations, when he was not actually at work. Whilst doing this, of course, he could not report the word *six* every half-hour. Not liking, however, to give up his beloved rambles, he tried to think how he could combine duty with pleasure. Then it was that he conceived the brilliant idea of making the clock act as a substitute for himself.

After a little puzzling over the matter, he made a wheel with notches cut in it at its outer edge, fixed this wheel to the clock, and then connected it by wires with the chief line circuit, so that it would regularly give every half-hour the word *six*.

At first all went well; but, after a little time, it was noticed that the letters *sf* could never be raised immediately after *six*. A detective operator was deputed to find out the cause of this, with the result that Edison's labour-saving device was discovered.

We may say here that that device is the District Telegraph of to-day, for, later, it was patented, and sold to the American District Telegraph Company.

The next time Edison evaded his duty by a device he was promptly found out. The telegraph clerks had sometimes the order to stop certain trains, and then give information to the train-despatcher of their arrival. Not knowing what a very small space of time he had at his disposal, upon one occasion, Edison reversed the order, and sent word to the train-despatcher before signalling for the train to stop. The consequence was that the train passed the station without stopping, and was nearly out of sight when he returned.

Too late young Edison realised the danger of the situation, and tried to get to a certain luggage depôt, where trains often stopped, hoping that there he would be able to stop the progress of the train.

The night, however, was dark, the way was full of obstructions, and he was much too frightened to see clearly. In the end he fell into a sort of open drain, and bruised himself severely, and, before he could get out, the train had passed out of sight.

Wounded and breathless, in terrible alarm, he tore across to the telegraph office, where word was instantly despatched, although it was not in time to prevent the dreaded collision, which would have taken place had it not been for the exceeding vigilance of both engineers. As it was, no harm was done to the train.

Edison's fault, however, was of too grave a nature to be allowed to go unpunished. In dire displeasure the general manager, Mr W. J. Spicer, sent for the culprit.

'Young man,' said Mr Spicer, 'this offence of yours is a very serious one, and I think I shall make an example of you. I can send you to the penitentiary for five years'——

Fortunately for Edison, just at that moment two English gentlemen of some importance came in, and Mr Spicer rose, with great affability, to greet them.

Whilst he was taken up with talking to these strangers, Edison perceived that he was not noticed just then, and so slipped quietly away and made off for the luggage depôt, where he found a train just on the point of starting for Sarnia.

Knowing the conductor of this train, Edison told him he would like to take a trip up the line with him as far as Sarnia.

Thereupon the man good-humouredly bade him 'jump aboard,' and in a few minutes Edison and the train were out of sight of any one at Stratford.

'My pulse,' said Edison afterwards, 'didn't get down to normal work until the ferry-boat between Sarnia and Port Huron had landed us in the latter town.'

Of course he lost the wages due to him, but that was a small matter compared with the danger he had escaped.

Once more at Port Huron, Edison found himself able to be of signal service to the telegraph-operators there. The winter having been exceedingly severe, the masses of ice had formed to such an extent and with such force as to sever the cable between Port Huron and the city of Sarnia. The river, which was a mile and a half wide at that point, was totally impassable, and all telegraphic communications were prevented. But Edison was not to be daunted by such difficulties. His inventive mind soon thought of a remedy. He would make short and long sounds express the dots and dashes of telegraphy, and jumping on a locomotive, he made the whistle sound the message.

'Halloo, Sarnia!' he said in this way, 'Sarnia, do you hear what I say?'

At first there was no response from the Sarnian operator.

Again and again the short and long toots shaped themselves into the dots and dashes of telegraphy.

The spectators on the bank watched with immense excitement. And at length the answer came. It was perfectly intelligible, and the connection between the two towns was once more open.

Now, young Edison began to be talked about, and his wonderful abilities were recognised, so that he found no difficulty in obtaining employment.

CHAPTER IV.

EARLY INVENTIONS.

EDISON next worked as a telegraph operator at Adrian, Michigan, and then at Fort Wayne and Indianapolis, gaining considerable credit, although his love of fun and love of experimenting often caused him to break the rules made for the knights of the key, as those who used the Morse alphabet have been called.

At Indianapolis he got into serious trouble on that account, but it was there his inventive faculty developed rapidly, to his exceeding satisfaction. How hard he worked! At an age when food and sleep are so necessary to the growth and well-being of the young, he robbed himself of both, that he might toil at disentangling the wonderful discoveries which followed one another in succession as he bent his active mind to look for them.

He has himself described the invention of his automatic recorder in a conversation with Mr Lathrop. 'I worked a "plug circuit" in the day-time at Indianapolis,' he said, 'and got a small salary for doing it. But at night, with another operator called Parmley, I used to receive newspaper reports just for the practice. The regular operator was a man named Williams; and, as he was given to copious libations, he was glad enough to sleep off the effects while we did his work for him as well as we could. I would sit down for ten minutes, and "take" as much as I could from the instrument, carrying the rest in my

memory. Then while I wrote out, Parmley would serve his turn at "taking," and so on. This worked well until they put a new man on at the Cincinnati end. He was one of the quickest despatchers in the business, and we soon found it was hopeless to try to keep up with him. Then it was that I worked out my first invention, and necessity was certainly the mother of it.

'I got two old Morse registers, and arranged them in such a way that, by running a strip of paper through them, the dots and dashes were recorded on it by the first instrument as fast as they were delivered from the Cincinnati end, and were transmitted to us through the other instrument at any desired rate of speed or slowness. They would come in on one instrument at the rate of forty words a minute, and we would grind them out of the other at the rate of twenty-five. Then weren't we proud? Our copy used to be so clean and beautiful that we hung it up on exhibition; and our manager used to come and gaze at it silently, with a puzzled expression. Then he would depart, shaking his head in a troubled sort of way. He could not understand it, neither could any of the other operators; for we used to drag off my impromptu automatic recorder and hide it when our toil was over. But the crash came when there was a big night's work—a Presidential vote, I think it was—and copy kept pouring in at the top rate of speed, until we fell an hour and a half or two hours behind. The newspapers sent in frantic complaints, an investigation was made, and our little scheme was discovered. We couldn't use it any more.'

This early and comparatively rude contrivance, which was only meant to serve a temporary and very practical purpose, was the germ whence sprang, later on, Edison's greatest invention, the phonograph, and was also the

source of his first finished invention, 'the automatic repeating telegraph.'

The immediate result of Edison's using his automatic recorder at Indianapolis, however, was that, when his device was discovered, he was dismissed by the indiscriminate manager.

At Cincinnati, however, Edison soon obtained another engagement as day operator, with a salary of sixty dollars a month. Whilst he was there he worked at night practice whenever he could obtain the use of the wire.

Several Cleveland operators came to the Cincinnati telegraph office one day, bent upon founding a local branch of the telegraphists' union. This occasioned the telegraph operators to try to promote brotherly feeling between the strangers and themselves that night, by the mistaken yet old-fashioned plan of drinking together. Edison had no mind for such revels, so he returned alone to the office, where no one was to be seen but the office-boy. The Cleveland wire was demanding a report, but at first Edison did not like to take upon himself the duty of supplying it. After a while, however, he resolved to do so, and manipulated the wire with his usual ability.

Long he worked during the silent hours of the night, and the next morning, by eight o'clock, he was in his accustomed place as day operator. He intended, with his usual kindness of heart, to keep the conduct of his fellow-telegraphists secret, but the office-boy told what had happened. Thereupon Edison's employers, being much pleased with his behaviour, gave him an increased salary of one hundred and five dollars, and placed the important Louisville wire in his hands. This wire carried all the southern reports, and required the skill of an expert. Edison entered into brisk competition with Mr Robert

Martin, a gentleman renowned for his telegraphing ability, and this was for Edison a very advantageous partnership.

Memphis, Tennessee, was the next place to which young Edison moved. Here he received one hundred and twenty-five dollars a month, as well as rations. But he did not remain long at this place, for his wonderful cleverness, which excited admiration in those who were just and generous, exposed him here, as elsewhere, to the jealousy and distrust of a narrow-minded and selfish master.

It happened that, when Edison arrived, the manager was trying in vain to make a repeater of his own invention more perfect. Edison at once began to make experiments, which were so successful that the result was that Louisville and New Orleans were connected for the first time by telegraphy. Enraged at Edison's great success in a matter in which he had failed, the mean-spirited manager brought a false charge against the youth, which led to his dismissal.

CHAPTER V.

AT LOUISVILLE.

'I WILL walk to Louisville,' thought penniless, sore-hearted Edison, who was still only seventeen years of age, and forthwith set out to tramp a hundred miles, and then obtain free conveyance for the remainder of the way.

His dismissal had come at a bad time for him. As much of his salary as he had not sent home was spent in books and instruments, and his dress was in a truly dilapidated condition. His health, too, was suffering from

the strain of much labour and sleepless nights. But his indomitable spirit sustained him.

On the way a young operator, named William Foley, joined him at Nashville, and the two went on their journey together until they reached Louisville.

It was a cold and cheerless morning in the beginning of winter when the two lads entered the great city with its ice-bound streets. A church-bell was clanging the hour of six. Faint with cold and hunger, weary with walking, disheartened by ill-treatment, in broken shoes and torn clothing, Edison presented himself at the telegraph office and asked for work. His appearance was against him, and he was naturally regarded with distrust, if not contempt. However, his bright and earnest manner made them listen to him, and the tests of skill which he proceeded to give the manager were so good that he was forthwith engaged as operator.

His new fellow-workers being vulgar and unprincipled, were inclined to ridicule one so poor and rustic-looking, but in time his unfailing kindness and studious hard-working habits won their respect and liking.

Edison continued in that situation two years. One little break in that time was, however, caused by his giving credence to rumours that came to the city of the wonderful resources of Southern America, which made him start off for that country with two friends. At New Orleans, however, he met an old and experienced traveller, who persuaded him to return home, saying that he would not find a better government, climate, or people anywhere than in the United States. After a short interval, therefore, he resumed work at Louisville, and here he soon had a laboratory, printing office, and machine shop in which he could work. He went to second-hand book stores, and

collected quite a library of books. He took press reports; on one occasion taking the Presidential message and veto of the District of Columbia Bill by Andrew Johnson at one sitting, which lasted from 3.30 P.M. to 4.30 A.M. Then he paragraphed the matter received over the lines, so that each printer had three lines to do, and a column could be set up in two or three minutes. For this the Louisville press gave him a dinner, and he was accorded several privileges.

Once, when a new man knocked him down for trying to limit his indulgence in strong drink, Edison's fellow-operators fell upon the man, and thrashed him so severely that he had to go to the hospital for three weeks.

As soon as Edison got a little better off as regards money, his kindly disposition made him so generous to others that he was sometimes not a little sponged upon. The demoralisation caused by the war led many telegraphists to tramp from city to city in search of work, which their unsteady habits soon caused them to lose again. Mindful of his own 'tramp' in search of employment, Edison would offer food and lodging to such poor fellows. And it was they who oftenest imposed upon his good nature.

One day he bought fifty volumes of the *North American Review* at an auction sale, placed them in his room, and went out again to his work. During his absence six telegraph operators, whom he was sheltering at the time, thought they would make use of his new purchase. Accordingly, they carried the books to a pawn-shop and procured drink with the money raised upon them. History does not describe Edison's feelings when he found himself thus wronged, or the way in which he treated the rascals for abusing his hospitality.

Another time, on coming home from a night's work, he

found the furniture in his room absolutely wrecked, and two of his visitors in bed with their boots on.

Edison pulled them out, and left them to cool upon the floor.

Once when he was returning in the night from an auction sale, with a load of books upon his shoulders, a policeman took him for a burglar, and shouted to him to stop. Being deaf, Edison did not hear him, and consequently took no notice of the shout, whereupon the policeman fired a pistol shot. Then, coming up to Edison, he recognised him, and allowed him to pass on.

Whilst Edison was at Louisville he published his first electrical treatise, and learned a very rapid style of penmanship, which enabled him to write clearly and legibly forty-five words a minute.

After a while the old telegraph office was exchanged for a spacious building, well fitted up with every kind of appliance. But with these improvements came more stringent regulations. The instruments and chemicals were required to be kept strictly in their places. As often before, Edison, whilst intent upon inventing, disregarded these regulations. One night he went into the battery-room to obtain some sulphuric acid for an experiment he was making. In getting the acid, he unfortunately upset it. The consequences were truly alarming. In his own words, 'the acid in the carboy tipped over, ate the floor, and went down to the manager's room below, ate up *his* desk and all the carpet.'

The next morning Edison was dismissed. The Board before which he was summoned said witheringly that they wanted telegraph operators, not experimenters.

CHAPTER VI.

BOSTON EXPERIENCES.

EDISON'S next situation as telegraph operator was at Cincinnati. There a machine-shed belonging to the railway company was so near the telegraph office that the temptation to experiment with an engine, and study its mechanism and capability, proved irresistible. One night, when the engine-driver and fireman had fallen asleep, Edison borrowed one of the larger engines, and drove it a certain distance along the line and back again. Perhaps he would not have been discovered had not inexperience caused him to over-fill the boiler, so that it sent out a discharge of dirty water and soot, which afterwards betrayed him. But he obtained valuable knowledge in this and other ways, which eventually led to his invention of electrical railroading.

After a while he went to Port Huron for eighteen months, where, in a situation as telegraph clerk, he continued experimenting and making inventive schemes, at the same time reading as much as he could from books supplied by the local library.

Sometimes Edison has been spoken of as a discoverer, but he did not like that word applied to himself. 'Discovery is not invention,' he said. And again, 'A discovery is more or less the nature of an accident;' adding, 'It is too much the fashion to attribute all inventions to accident, and a great deal of nonsense is talked on that score. In

my own case but few, and those the least of my inventions, owed anything to accident. Most of them have been hammered out after long and patient labour, and are the result of countless experiments, all directed towards attaining some well-defined object.' Thus we see that the crude experiments of his early youth were often the germs whence sprang, later on, the wonderful world-helping inventions which have made him without question the greatest living inventor.

Whilst at Port Huron, Edison made a clever device whereby a submarine cable could be used for two circuits, this causing a considerable monetary saving. The Grand Trunk Railway adopted this invention, and gave him a free pass to Boston, where Mr Milton Adams, his good friend, procured him a situation in the Franklin office.

As usual Edison, now twenty-one years old, was very short of money, the home claims upon him, his generosity to others, and the cost of his scientific appliances, having absorbed all his earnings. His appearance, therefore, upon arriving at Boston in his old, well-worn clothes, after a four days' journey, was anything but prepossessing.

'When shall you be ready to begin work?' asked the manager, when he arrived at the telegraph office.

'Now,' replied the young man.

He was then told to return at 5.50 P.M.

Accordingly he did so, and, after having been introduced to the night manager, made the acquaintance of the night staff with whom he was to work. These men were much amused at his shabby appearance, and, dubbing him 'a jay from the woolly West,' thought that they would have a joke at his expense. After consulting together, they gave him a pen, and assigned him the New York No. 1 wire. Then, after some little delay, he was called over to

a table to take a special report for the *Boston Herald.* Now the plotters had arranged that, for his discomfiture, one of the fastest senders in New York should send him the despatch. Edison sat down and began to work. He had long since, as we have seen, attained to a very rapid style of writing, and had perfected it to such an extent that he could increase it from forty-five to fifty-four words a minute, by writing smaller and smaller as he proceeded. At first the New York operator began to send slowly, then he increased his speed. Edison gradually adapted his pace to the sender's. The latter soon sent at his very fastest. Looking round quietly, Edison saw that his fellow-workers were watching over his shoulders, with no little excitement. That betrayed them. But, taking no apparent notice, he went on, calmly sharpening a pencil now and then, to their no small astonishment. Then the New York telegraphist worked very carelessly and hurriedly, letting his words run together; but Edison, undismayed, went on until he had nearly done the special report. Then he opened the key, and said calmly, 'Say, young man, change off, and send with your other foot.' Upon that, the New York man gave up trying to overwhelm him, and allowed another clerk to take his place.

The great ability he had displayed under trying circumstances secured the respect of Edison's new associates, who saw in him one of the most expert operators in the country.

His active mind was then, as ever, full of schemes for achieving wondrous labour-saving and beneficial inventions. Even during sleep, his brain was busy devising intricate machines, which he was not, however, able to remember when he awoke. One rather amusing instance of his applying his inventive mind to the exigencies of an unusual

position occurred about this time. It happened that the telegraph premises were overrun with a numerous army of cockroaches, against whom the telegraph clerks had long waged a vain and inglorious warfare. Overpowered by numbers, hourly increasing, when Edison came upon the scene the men were decidedly the defeated party. No hiding-places could secure for them immunity from the pest, no shelf or hook was safe from the active climbers: over books, appliances, food, and clothes, onward came the enemy. Edison's device for exterminating them was simple, yet effective. Fastening some shining strips of tinfoil on the wall, he smeared these with such food as beetles love, and connected the strips with a powerful battery. Then the poor calcined insects poured down from what was for them a crematory.

Edison's friend, Mr Milton Adams, happened at that time to be himself experiencing a reverse of fortune, and the youth gladly gave him board and lodging for a while. His sympathy was very helpful, and together the friends frequented second-hand book stores, and sought for scientific appliances in queer old shops, or investigated the grand resources of the Boston Public Library, which contained a collection of two hundred and eighty thousand volumes. Edison's present manager, too, gave him sympathy and appreciation such as he had not often met with.

Once, when he was very busy experimenting, he bought the whole of Faraday's works on electricity, and, having brought them home at three o'clock in the morning, read without stopping until Mr Adams got up, and it was time for them to adjourn for breakfast to the place, a mile distant, where they took their meals. Edison was full of interest and excitement about what he had been reading.

'Adams,' he said, 'I 've got so much to do, and life is so

short, that I'm going to hustle,' and so he set off running to his breakfast.

Next, we have a glimpse of him, at six o'clock one morning, carefully letting down a bottle into a sewer at the corner of State and Washington Streets. The bottle contained nitro-glycerine made by himself and a mechanic with whom he had formed an acquaintance. Having tested a small quantity of this explosive, it produced such alarming results that they decided the sooner it was out of their way and that of every one else, the better it would be; hence its immersion in the sewer.

Not long after coming to Boston, Edison commenced to make his electrical vote-recorder, which caused his first appearance at the Patent Office. Having been struck with the great waste of time occasioned by the old way of taking votes in Congress and in the State legislatures—half an hour or more being required to count the 'Ayes' and 'Noes'—he made a machine, something like the hotel annunciator that was invented long afterwards, although more complicated. Edison thus described this ingenious invention: 'In front of each member of the House were two buttons, one for "Aye" and one for "No." By the side of the Speaker's desk was erected a square frame, in the upper part of which were two dials, also corresponding to the two classes of vote. Below these dials were spaces in which numbers appeared. When the vote was called for, each member pressed one or other of the buttons in front of him, and the numbers of "Ayes" and "Noes" that had been cast at once appeared automatically on the record board. All the Speaker had to do was to glance at the dial and announce the result.'

This device would save several hours of time for the public every day in the session, and Edison spared neither

time nor money to secure its introduction. Having interested a moneyed man in the venture, they went together to Washington. 'We got hold of the right man,' said Edison afterwards, 'to get the machine adopted, and I enthusiastically set forth its merits to him. Just imagine my feelings when, in a horrified tone, he exclaimed, "Young man, that won't do at all. That is just what we do not want. Your invention would destroy the only hope the minority have of influencing legislation. It would deliver them over, bound hand and foot, to the majority. The present system gives them a weapon which is invaluable, and, as the ruling majority always knows that it may some day become a minority, they will be as much averse to any change as their opponents." I saw the force of his remarks, and was about as much crushed as it was possible to be at my age.'

The vote-recorder got no further than the Patent Office, and, ever after, Mr Edison made a point of investigating carefully the utility of any invention before taking the trouble to perfect it.

While employed by the Western Union Telegraph Company at Boston, Edison invented a dial instrument for people to use who wished to have private wires in their houses or offices, and did not want to trouble to learn telegraphy. He also invented a private-wire printer besides. But his most successful work was the first conception and partial development of a stock-quotation printer, for printing the price of stock in brokers' offices.

Edison was now in such high repute at Boston that he was chosen by a ladies' academy to lecture on telegraphy. Being exceedingly busy at the time, he forgot about the engagement, and, when sought hurriedly by his friend, Mr Adams, was found at the top of a house, busily erecting a telegraph wire. When reminded of the lecture, forgetting

again that it was an academy of ladies he was going to address, he set off in his untidy old clothes, just as he was, to give the lecture. Hurrying through the streets and into the hall, he suddenly found himself in view of an assembly of stylishly dressed young ladies. This was overwhelming, indeed; but Edison, although feeling disconcerted, bravely plunged into his subject, and gave his fair hearers a happy and clear explanation of telegraphy.

The girl graduates admired the frankness and presence of mind of their learned, but badly dressed lecturer, and showed their approval afterwards by their sweet, gracious behaviour to him when they met.

CHAPTER VII.

QUADRUPLEX TELEGRAPHY.

'  KNEW Tom [Edison] when he was a barefoot boy living at Fort Gratiot, Michigan,' said Mr S. J. House to a press reporter; 'he was always hankering after telegraphy, and once rigged up a line from his house to mine, a block away. I could not receive very well, and sometimes I would come out, climb on the fence, and halloa over to know what he said. That always angered him; he seemed to take it as a reflection upon his telegraph line.'

And now that same barefoot boy, grown a man and already remarkable for his abilities as a telegraphist and inventive talents, set to work zealously to improve the system of electric telegraphy.

The idea of the electric telegraph occurred to Professor Morse in 1832, and in 1837 he made his first somewhat rude apparatus, and set his system to work. Excellent

as it was fundamentally, yet it had imperfections and limitations, which Edison sought to remove patiently and with great success. Less expensive, easier to work, more rapid became the system as altered and modified by him, until, after six years, he accomplished his greatest effort in that way—the discovery of quadruplex telegraphy. Let me explain.

The rapid increase in the business of telegraphy called forth the exercise of the ingenuity of telegraph engineers to increase the capacity of a single wire for the transmission of messages. Duplex telegraphy is one way in which this is done. By this system messages can be sent on one line in both directions at the same time. For instance, a man at Station A can send a message to Station B, at the same time that an operator at B is sending a totally different message to A. But if Station A or Station B is able to send two messages to the other at the same time on the same wire, we have diplex telegraphy. When these two systems duplex and diplex are combined, we may have four messages sent simultaneously on a single wire, and this constitutes *quadruplex* telegraphy.

The invention of quadruplex telegraphy is universally held to be Edison's crowning achievement in telegraphy. In America alone it has effected the enormous saving of 15,000,000 dollars, by immensely lessening the number of wires required for the telegraph work.

Like Edison's other inventions, quadruplex telegraphy was the result of long-continued patient study and experimenting. It had been suggested by Stark and Bosscha in 1855, but it was not until 1874 that Edison's device solved the difficult problem of how it was to be done, and the system now in use is the practical result of his efforts, supplemented by those of others. It may be broadly

described as the duplex system provided with two keys in the sending circuit, and two relays, each having a coil in both the line and the compensation circuits. One key is so connected that, when its lever is depressed, the battery connections are reversed, so reversing the direction of the current, while the other key is so constructed that the depression of the lever brings into circuit three times as much battery power, so that (whatever the direction of the current) it is increased in strength threefold. The relay at one end responds correctly to the 'marking' and 'spacing' currents, whatever their strength; while the relay on the other end is actuated only when the greater current is received, and then responds whether the 'current' is positive or negative.

Edison is still busy with experiments which he hopes will extend the quadruplex system into a sextuplex, or even octuplex one. If he succeeds, six or eight messages can be sent simultaneously over the same wire.

But to return to Edison at Boston. The same year 1869, in which his engagement there terminated, he had so far perfected his duplex system that he determined to make a trial of it. Mr F. L. Pope, Patent-adviser of the Western Union Telegraph Company, very kindly assisted him to do this. The results were imperfect, but Edison perceived in them the germs of great things. He resolved at once that he would go and carry out his schemes in a wider sphere of action.

Accordingly he went to New York, after having taken a trip to Rochester, where he wished to try his new invention by the wires of the Pacific and Atlantic Railway Company. The trial, however, resulted in failure, because the telegraphist at the New York end could not understand how the invention should be worked.

CHAPTER VIII.

FROM POVERTY TO RICHES.

WHEN Edison came to New York he was painfully poor, for besides his empty pockets, he was loaded with a debt amounting to two or three hundred dollars.

For three weeks the young man had a hard time of it. Hunger, rough lodgings, and discouraging interviews with the heads of telegraph departments were most depressing. But there is an old saying that the darkest hour is just before the dawn, and when things are at their lowest ebb they often begin to rise; and so it was with Edison. Plunged into poverty and the contempt of man in a strange place, after all his brilliant achievements and his long toil of night and day, his soul was sinking within him, and his physical endurance was beginning to wane, when one day he found himself on the steps of the Laws Gold Reporting Company's Office, Wall Street. A crowd was surging about the place and elbowing its way inside the door, desperation in some countenances, trouble in all. Amidst the confusion, Edison passed into the office unnoticed, and standing by, observed with keen eyes exactly what was wrong, and also how to remedy it.

The office was the centre of no fewer than six hundred brokers' offices, with each of which it was connected by a system of indicators. It was in fact, in a way, the great heart of wide-spread commercial activity. And just then Wall Street was in a state of immense excitement about a

singular financial crisis. A panic threatened in the gold market; whole families were on the verge of ruin, fortunes trembled in the balance. Inflamed, unmanned by the lust of gold, men crowded round the centre whence news could be obtained, with cruel shouts of triumph or senile bursts of tears; and just at the time of all that wretched excitement, when the eyes of thousands were turned with frantic eagerness to see what statistics would be furnished by the hundreds of indicators, there in the Laws Gold Reporting Company's chief office, the stock-quotation printer, working by means of electricity, had suddenly collapsed, whilst with it was lost every subordinate source of information. Mr Laws was a very nervous man; his superintendent, Mr Frank Pope, resembled him in that respect; they were therefore almost driven off their mental balance by this dire misfortune. Six hundred brokers' boys, weighted with indignant messages from their chiefs, and a crowd of angry, excited people surging to and fro without and even within their office, drove them almost to desperation. What could they do?

'I think, Mr Laws,' remarked Edison quietly, after having calmly examined the broken-down printer, 'I can show you where the trouble lies. There is a contact spring which has broken and fallen between two cog-wheels, which prevents the gear from moving.'

It was indeed so. With gratitude Mr Laws looked at the shabbily dressed stranger whose cleverness had saved him from his most disastrous position. The obstruction was quickly removed from the quotation printer, and that important centre was again in touch with all its dependent organs.

Soon Edison found himself a hero gazed upon by hundreds of admiring eyes. And the end of it was that,

the very next day, Mr Laws gladly engaged him to take charge in future of all the machinery, and see that it ran successfully. His salary was fixed at three hundred dollars a month, which was very nearly three times as much as he had ever received before. Thus lifted out of poverty, and encouraged by the confidence of his new employer, Edison found himself in much more favourable circumstances for inventing. The stock-quotation indicator being in his charge, was much improved by him, but by-and-by he devised another, which was so good that Mr Laws exerted himself, and did not spare his money in introducing it.

The Edison stock printer, chiefly intended for the gold market, was made to print letters, figures, and characters from a double type wheel. This invention was a grand success. But the immediate result for young Edison was that he lost his situation, for a Consolidated Company was formed. The Consolidated Company, however, made overtures to him which he refused, entering instead into a partnership with a firm of electricians. Then he invented another and better gold-reporting printer, which was eventually bought by the Consolidated Company.

After working some time for the electricians, and receiving from them very much less remuneration than Mr Laws had given him, Edison left the firm and became connected with General Marshall Lefferts, the President of the Gold and Stock Telegraph Company. And now, under more advantageous circumstances, he invented some stock printers and private family telegraph appliances, with which the company was so pleased that it sent a committee to wait upon him, for the purpose of securing these inventions for itself.

Edison had made up his mind that the sum that the

company ought to pay him should be about five thousand dollars. But, wanting money badly as he did for further experiments, he was privately resolved to accept anything.

'How much do you want for your devices?' asked one of the members of the committee.

'Make me an offer,' replied Edison cautiously.

'Well,' said the other, 'how would forty thousand dollars strike you?'

Edison was so 'struck' that in his own words, he 'could have been knocked down with the traditional feather,' so astonished was he at the sum.

Of course he at once accepted it, but later began to fear that the offer was not genuine, and that he had been made the victim of a Wall Street trick. Two days afterwards, however, a large formidable-looking contract was brought him to sign, and after he had done so, a cheque on the William and Wall Street Bank was handed to him.

Strangely enough, Edison had never been in a bank before, so, when he went to get his cheque cashed, he was not at all certain what to do. He stood still, therefore, a little while, to see as he says, 'the mode of procedure,' and then proceeded to take his place in turn with others, at the paying clerk's window.

When his turn came and he presented his cheque, the cashier said something to him which he did not hear, and then proceeded to shout to him; but owing to his deafness, Edison was unable to understand what he wanted. Again the clerk shouted, but in vain.

Edison turned away, and sitting down dismally on the steps of the bank, concluded that he would never get that forty thousand dollars. Indeed he became so hopeless that, he said afterwards, any one might have bought that cheque of him for fifty dollars.

At last, however, he went back to the company's office, and told one of the clerks how he had failed to get the cheque cashed. Then it was explained to him that the cashier only wanted to know who he was, before paying over to him such a large sum. Returning to the bank with Edison, the company's clerk introduced him there, and the money was at once paid over.

CHAPTER IX.

NEWARK LABORATORY AND FACTORY.

IN less than six weeks after Edison received that memorable cheque for forty thousand dollars (about £8020), he spent most of it in fitting up a workshop of his own with everything necessary for his inventing and manufacturing work.

Several of these shops were occupied in succession by Edison, and in them much good work was done, and a large number of inventions turned out, most of which were in connection with printing telegraphs. Then he became associated with the Automatic Telegraph Company. This company had gained possession of the inventions of a Mr Little; which, however, proved more or less a failure, as they did not fulfil their promise. The company had made a line between New York and Washington, but they could not do business upon it, because Mr Little's apparatus failed them. At that point Edison was called in, and he speedily solved the problem so completely that the line was opened for business, much to the satisfaction of his employers.

Edison's services were meanwhile retained by the

Western Union Railway Company, the Gold Stock Company, and other influential firms, and in 1873 he entered into an agreement to give the former two companies the benefit of all his ideas relating to telegraphy. For this a very handsome salary was paid him, and high rates of payment were agreed to in regard to future inventions.

It was now necessary that Edison should have many assistants and a large sphere of operations. We therefore find him, in the year 1873, when he was twenty-six years old, located in a large laboratory and factory in Ward Street, Newark, with a partner, one Mr William Unger, and a staff of three hundred subordinates.

Very irregular and unbusinesslike were the arrangements in this large establishment. Edison disliked what he called the 'humbuggery of book-keeping,' and paid his men and kept his accounts in a fashion peculiar to himself. Perhaps his prejudice against book-keeping was increased by the incompetence of the man whom he at first employed as book-keeper. This fellow, upon winding up the books at the end of the first twelve months, made it out there was a surplus of seven thousand five hundred dollars. Edison was delighted when he heard this, and, with his usual generosity, determined that his men should share the general prosperity; therefore he gave orders for festivities which were to be carried out at his expense. But, before this was done, he began to reflect that it was really incredible that there could be such a large surplus of money after all his heavy expenditure in the pursuit of science. He therefore took the books himself, and after wrestling with them the whole of one night, discovered, to his dismay, that, instead of a surplus, the accounts showed a grave deficit of some fifteen

thousand dollars (more than £3000). The orders he had given were instantly countermanded, and henceforward he would have no book-keeper.

The men's wages and the bills generally were now paid by Edison in a somewhat erratic fashion. The hours of work also were as irregular as the pay-times, and all might have been confusion and insubordination if Edison had not been what he was. But he won the love of his men and their zealous sympathy by his bright winning enthusiasm and his sunny disposition. The men could discern their master's superior abilities in the humblest detail; his ready help was ever given to the meanest mechanic in his employ.

'We had no fixed hours,' he said, speaking of their work together, 'but the men, so far from objecting to the irregularity, often begged to be allowed to return and complete certain experiments upon which they knew my heart was set.'

Sometimes, when an experiment of unusual importance was to be made, and it was necessary that the work should be done expeditiously, Edison would pass through the laboratory, giving gifts liberally, and, by joking remarks about their dullness, inciting the men to greater exertions.

A good story is told us by Mr and Mrs Dickson of another occasion when the master-will commanded the situation by sheer force. Edison had received an order to supply thirty thousand dollars worth of his gold and stock-quotation printer, and for some reason or other the new instruments would not work. Edison thereupon went up to the top floor of his factory, with several of his scientific assistants, and, turning, locked himself and them in. 'Now, you fellows,' he cried, 'I've locked the door, and you'll have to stay here until this job is completed.'

And they remained there for sixty hours of hard work of mind and body, with no sleep and with scarcely any food. But at the end of that time the difficulty was conquered; what was wrong in the new instruments was discovered and rectified. After this great and long-continued effort, Edison slept for thirty-six hours, and then awoke feeling all right again and ready for fresh labours.

Now and again, in his moments of success, Edison's happy and still boyish disposition showed itself in scenes like the following. One day, on his return from New York, where he had just sold a favourite invention, he entered his workshop with a 'whoop.' Tossing his silk hat into an oil pan, he was just about to send his coat after it, when some one laughingly stopped him and took possession of the coat.

Once, when he had a number of schemes in his brain —amongst others the important quadruplex telegraph— which required great concentration of thought, Edison was served with a notice that unless he paid his taxes the next day—the last of the days of grace allowed—he would have to pay twelve and a half per cent. extra.

Accordingly he went to the City Hall, and took his place in the line of those who were going to pay their taxes. There were about a hundred people before him, and so Edison filled up the tedious interval by mentally working out his quadruplex telegraphy, and became so absorbed that he completely forgot what had brought him to the tax office.

'Now then, young man, look sharp. What is your name?' asked the official behind the counter when he mechanically stood before him.

Edison looked at the man in no little perplexity, and answered, 'I—I don't know.'

He was waived aside impatiently, others poured into his place, the clock struck the hour, the time of grace was over, and he had incurred the extra charge of twelve and a half per cent.

CHAPTER X.

MARRIAGE.

IT was about this time that a touch of romance came into Edison's life, as it comes into that of most men at least once in a lifetime. Amongst those who were members of the inventor's working force was one Mary E. Stillwell, whom the master learned to love. Her influence was gentle and elevating, as his mother's had been during her lifetime, and Edison's courtship of her—brief, and simple as was the nature of the man—ended in their happy marriage in the year 1873.

Mrs Edison retained her sympathy with the work-people amongst whom she had once laboured, and she is said to have been greatly beloved and highly esteemed by them. Well was it for Edison that he had now some one to look after his home comforts. Neglectful as he had ever been of necessary food and sleep when engaged on any special work, it was only his splendid physique—a physique which had never been injured by any form of dissipation—that enabled him to bear such deprivations. But one cannot with impunity for ever violate the laws of nature. With increased years, and the increased tension of an arduous life, greater care was necessary. Mrs Edison had no easy task before her. When he did condescend to pay atten-

tion to such subjects, Edison's views of domestic comfort were, to say the least of it, uncommon.

'I wish I may never eat the same thing twice in a month,' he said to his wife when she began housekeeping.

'Variety,' he repeated, on another occasion, 'is the secret of wise eating. The nations that eat the most kinds of food are the greatest.'

And he argued that there was a striking resemblance between material and spiritual laws, and held that in proportion to the elasticity of the diet provided for the body would be the capacity and the power of the mind, basing these assertions on the dietary and intellectual ability of the different nations. Rice-eating nations, he said, never got on well, or thought or did anything but rice, rice, rice for ever. The Irish, too, who ate potatoes and black bread, though naturally bright, were enervated by the uniformity of their food. On the other hand, the French, the most thrifty, well-mannered, educated, and accomplished people, had an immense variety of food. And when the Roman Empire was at the zenith of its grandeur, the food of its great men was delicate and richly varied. And so on, adding, 'A nation begins to decay, philosophically and morally, as soon as cooking is degraded from an art to an occupation.'

Edison's biographers remark that these youthful convictions of the great inventor have yielded in great measure to the larger views of his more mature manhood; and that is well, for history scarcely bears out his early assertions. With the luxurious epicureanism of the great Oriental and Latin nations came the sapping of their intellectual life, the degrading of their moral sense, the loss of political unity.

The year following his marriage was for Edison a year

of great creative activity. It was then that the famous quadruplex telegraphy, of which mention has been made, was given to the world.

At first this great invention met with much opposition from those who wanted to make it out that their own methods were as good or better, but its immense superiority at length was universally recognised, and it spread rapidly over the world.

Four years afterwards, the president of the Western Union stated that the invention was one of the most important in telegraphy, and had saved the company six hundred thousand dollars annually.

Edison received only a comparatively small sum for this world-renowned invention, which he spent entirely in making and bringing out his octuplex, an instrument which would send eight messages at the same time over the same wire.

Three children, Marian and Thomas Alva (nicknamed Dot and Dash), and William Leslie, were born to Edison and his wife. But their union was comparatively a short one; for, eight years after their marriage, in the year 1881, Edison had the great sorrow of losing by death his intelligent, sympathising, and beloved wife.

CHAPTER XI.

DIVERS INVENTIONS.

'A YOUNG man who has kept the path to the Patent Office hot with his footsteps.' Thus the United States Patent Commissioner described Edison at the comparatively early age of twenty-four years.

And it was indeed astonishing to the beholders to see the number and the excellence of his inventions.

Large and complete as the laboratory and factory at Newark seemed to him, after his former quarters, so great were the works done in it—at one time he had forty-five separate inventions in different stages of completion—that he found he required many things impossible to get on the Newark premises. His growing fame, too, caused the place to be thronged with visitors, who came there sometimes from a love of science, but oftener from vulgar curiosity. To escape from these, and to obtain greater facilities for his work, Edison took his family and the whole establishment to Menlo Park, a quiet spot about twenty-four miles from New York.

At this place he built a large and splendidly fitted up laboratory, with every accessory that could assist him and his followers in their work. He declared that when the public tracked him out there, he would simply have to take to the woods.

It is interesting to read the description of the large and costly appurtenances of this mighty workshop, from its splendid scientific library of the newest and most reliable works of reference, to the pipe-organ of good tone and dimensions and the musical box, which were so frequently useful when the inventor thought that the soothing influence of music would assist him or his employees in their arduous duties.

From the wonderfulness and variety of the feats of scientific skill which were accomplished in this quiet retreat, its owner has been designated 'The Wizard of Menlo Park.'

Let us glance at some of these inventions. There was, first, the carbon telephone transmitter. The telephone, as

first used, bore Bell's name, having been invented by Professor Alexander Bell. It was in need of one thing to make it thoroughly practicable, and that was the transmitter, which Edison forthwith invented and patented. In this transmitter carbon was employed to translate sound into electric waves. Let me explain. To transmit speech by means of electricity, the current must not be suddenly interrupted, but made to vary in strength in exact conformity with the rapidly changing motion of the sound-bearing waves. The strength of a current may be varied in two ways—the current-producing power may be altered, or the resistance that the current has to encounter may be changed. Thus, as Professor Barrett points out, in scientific phraseology, the strength of the current is equal to the electro-motive force divided by the resistance in the path of the current.

In the telephone invented by Professor Bell, the voice produces variations in the numerator of this fraction. It has both to make the current as well as to make it vary in accordance with itself. This works well enough on short lines, but will not do for long ones, because the strength of its current depends entirely upon the voice itself.

In Edison's telephone the voice has merely to vary the resistance in the path of the current (the denominator of the fraction), and not to produce the current itself, which was produced by coarser means. The best form of a telephone on this principle was invented by an American named Elisha Gray. His invention, however, was not practicable; but Edison succeeded where he failed.

Having obtained a current from an ordinary voltaic battery, Edison's object was to make the voice vary the resistance in its path. For this purpose he devised all

sorts of ingenious contrivances for transmitting speech on this principle. But one by one they were proved faulty and abandoned until, in 1877, he tried a thin film of plumbago on ground glass included in the circuit, a spring being attached to the vibrating diaphragm, the end of which rested on the film, so that, as the diaphragm moved, more or less of the film was included in the circuit. By degrees this led to the use of small cylinders of plumbago against which the diaphragm passed. The articulation was poor, but conversation could be understood. At last, however, Edison made a transmitter which had a button or wafer of some semi-conducting substance between two discs of platinum. The slight pressure of a piece of rubber tubing secured to the diaphragm, and resting against the outside disc, maintained electrical connection between the button and discs. Thus the vibrations of the diaphragm were able to produce the requisite pressure on the platinum disc, and in that way vary the resistance of the button included in the primary circuit of an induction coil. A button of solid plumbago, such as is employed by electrotypers, was first used with what were considered excellent results, for everything transmitted came out moderately distinct, but the sound altogether was not greater than that of the magneto-telephone.

Again and again Edison tried other semi-conductors, until he hit upon some lampblack which had been taken from the chimney of a smoking petroleum lamp. It was intensely black. Edison made a small disc the size of sixpence of this black substance, and placed it in the telephone. The result was excellent, the articulation being distinct, and the sound much greater than with telephones worked on the magneto principle. When, however, with the line being very long, there was a great permanent

resistance in the circuit, the alterations of resistance produced by the voice in the carbon wafer, and thus in the current strength, were almost imperceptible. Edison met this difficulty, and conquered it to a great extent by employing an induction coil in the current. A coil consisted of two parts—a short thick coil of wire called the preliminary coil, surrounded by a long thin wire, the secondary coil. A current of electricity flowing through the former induced currents in the latter, and the least difference in the strength of the primary current caused a considerable fluctuation in the secondary coil. Now Edison's carbon transmitter was included in the primary circuit, no direct battery current being sent along the line, but only induced currents from the secondary coil. Edison next found that the thin vibrating diaphragm was not necessary, and so he attached the carbon wafer rigidly to a comparatively thick plate of iron against which the voice was directed. The result was wonderful; a whisper three feet from the telephone was clearly heard and understood at the end of the line.

Having sold the right to use this transmitter to the Western Union, whilst Bell's instrument was in the hands of Boston capitalists, a fierce competition ensued.

'In England,' said Edison, when describing the matter, 'we had fun. You see neither the Bell people nor we could work satisfactorily without injuring the other. They infringed on my transmitter, and we infringed on their receiver; and there we were, cutting each other's throats. Well, of course, this could not go on for ever, and consolidation had to come, although a second fight over the terms of this consolidation was bound to come. In a measure they had the whip hand of us; so I was not surprised to receive one day from our representative in England a telegram, the gist of which was that the Bell

people wanted more than their full share of the receipts in case of consolidation, and that our agent was at his wits' end what to do. I cabled back at once, somewhat to this effect: "Do not accept terms of consolidation. I will invent new receiver and send it over." Then I set to work. I had found out some time before that electricity altered, in some mysterious way, the co-efficients of friction in moving bodies, and I determined to turn this fact to account. In three weeks I had a receiver finished which worked even better than the Bell, and in less than no time afterwards we had got six hundred of them made. With those we started off a body of men on a quick steamer; and an instructor went along, who, during the voyage, taught the men how to manipulate the new receivers, and how to make them if more should be required. The new receivers, immediately on their arrival in England, were attached to the instruments in all our stations; and this brought our opponents round. We consolidated on equal terms shortly afterwards.'

Edison called this new receiver the motograph. It is very ingenious. A carbon point presses upon a revolving cylinder. A current of electricity passing through this makes the carbon point press more or less heavily upon the cylinder according as the current is strong or weak or intermittent. The vibrations of the diaphragm give this varying action to the current, and, by the principle of 'give and take,' another diaphragm at any distance vibrates sympathetically with that affected by the sound waves.

Then Edison invented the micro-tasimeter, an exceedingly delicate instrument for measuring inappreciable degrees of heat. The name of it is taken from three Greek words, and means 'minute-pressure-measurer.' Edison him-

self explains its principles thus: 'It consists of a carbon button placed between two metallic plates. A current of electricity is passed through one plate. A piece of hard rubber, or of gelatine, is so supported as to press against these plates. The whole is then placed in connection with a galvanometer and an electric battery. Heat causes the strip of rubber to expand and press the plates closer together on the carbon, allows more current to pass through, and deflects the needle of the galvanometer. Cold decreases the pressure. Moisture near the strip of gelatine can be measured in the same way by increasing or decreasing the pressure, and accordingly deflecting the needle. By means of this apparatus, or one combined with sensitive electrical galvanometers, it is possible to measure the millionth part of a degree Fahrenheit.'

In a solar eclipse which occurred soon after he had invented it, Edison discovered with the instrument traces of heat in the outer gaseous envelope of the sun, known as the corona. Not only was the capacity of the tasimeter found sufficient for the registration of the desired phenomenon, but it was found that the heat from the sun's corona went ten times beyond the index capacity of the instrument.

Edison's tasimeter was now brought into public notice, and the *Scientific American* for October 1878 said:

'Seeing that the tasimeter is affected by a wider range of etheric undulations than the eye can take cognisance of, and is withal far more acutely sensitive; the probabilities are that it will open up hitherto inaccessible regions of space, and possibly extend the range of aërial knowledge as far beyond the limit obtained by the telescope as that is beyond the reach of unaided vision. Possibly, too, it may bring within human ken a vast multitude of nearer

bodies—burnt-out suns, or feebly reflecting planets, now unknown because not luminous.'

Exceedingly sensitive is the tasimeter. A lighted cigar several feet away will throw the light off the scale, as may also the heat from a human body standing eight feet off and in a line with the cone; and the radiance from a gas jet one hundred feet away causes a noticeable deviation.

Moisture also causes a very perceptible alteration in the gelatine. One day, when he was experimenting, the great inventor put a strip of gelatine between the upright pieces of carbon, and then held a strip of damp paper three inches away from the gelatine. Instantly the latter expanded, causing the needle to shift eight degrees. A drop of water upon the tip of the finger five inches away deflected the needle eleven degrees.

This instrument has been found very useful for the detection of icebergs at sea. For that purpose it is put into a case which is connected with the ship's keel, and attached by wires which run from a kind of Daniell battery to a common galvanometer in the captain's cabin. As cold causes the compressing rod to contract and warmth makes it expand, the deflections caused in that manner are brought at once before the captain's sight, so quickly that he has sufficient time to guard against the danger. Thus, before the huge ice-mountain can bear down upon the fragile ship, it is enabled to get far away in an opposite direction.

The tasimeter also shows with equal promptness and accuracy when a sudden fire has broken out.

The odoroscope is a modification of the tasimeter, and is so named from its usefulness in measuring odour inappreciable to the human sense.

The microphone, which was invented by Edison about

this time, has some resemblance to a telephone, with this difference, that it magnifies sound in transmitting it. So much so, indeed, that it is alleged the movement of a little camel's-hair brush is magnified into a great roar like the rushing of a mighty wind through the murmuring leaves of forest trees; a tiny gnat buzzing about gives a sound like the tramping of troops; whilst the ticking of a watch and the beating of the human heart can be heard an altogether incredible distance off.

In the mechanism of the microphone there are several upright carbon pieces, each supported by a light spring. To the diaphragm is attached a carbon button, against which the first carbon piece rests, and the vibrations in the diaphragm are passed in turns from carbon one to carbon two, and so on, with the result that the sounds communicated to the telephone receiver are most marvellously heightened.

Two of Edison's other inventions, which are not yet used in commerce, are the megaphone and aërophone. The former is a device by which distant sounds may be brought to the ear by means of nothing but the air and two funnels six feet long, mounted on a tripod, and tapering from a diameter of two feet six inches at the mouth to a small opening attached to which are tubes for the ears. Men some miles apart have been able to converse by means of this instrument, and the sound of cattle crunching grass six miles away has been heard by listeners at Menlo Park.

The aërophone is a sort of exaggeration of the phonograph. It is an instrument which not only transmits the ordinary tones of the voice to an indefinite distance, but also magnifies them two hundred times. In fact, it not only catches up casual and indiscreet remarks, but roars

them out to the adjoining neighbourhood. When the public was apprised of Edison's new invention, the aërophone, it was ridiculously angry at this invasion of its privacy, and shrank from the exposure which such a tell-tale instrument might bring about. The public would therefore have nothing to do with it, and perchance in that it acted wisely.

'Why in creation, Edison,' said a merchant, one day, to the great inventor, 'don't you turn your attention to inventing something that would save this endless waste of time and labour?' The speaker was referring to the toil and tediousness of much writing.

Edison pondered over the casual hint, and the result of his meditations, and the experiments consequent upon them, was that he invented the electric pen. Here, as Professor Barrett observes, there is no new scientific principle, but merely an ingenious arrangement whereby a very swift to-and-fro motion is given to a needle point by means of a tiny electric magnet. The object is to puncture the paper which is written upon by the pen, so that the record of the handwriting is left in a myriad of minute holes. Thus a paper stencil-plate is formed, from which many hundred impressions can be taken by means of an ordinary inked roller. The construction of the penholder is very simple. It consists of a needle, the point of which projects scarcely a hundredth of an inch beyond its enclosing sheath. At the upper part of the small fly-wheel, the shaft of the wheel forms a tiny crank, which is attached to the needle; as the wheel revolves, the needle point is rapidly pushed out of the sheath and pulled back, just like the sting of a bee. The revolution of the fly-wheel is accomplished by a small electro-magnet animated by a single voltaic cell. So swift is the motion

of the needle that rapid writing is not impeded—a hole is punched in the paper, and the needle withdrawn more rapidly than the muscles can move the pen. Every letter is thus traced out in innumerable small pin-holes, through which the ink can be squeezed when copies have to be taken, while the holes are so close together that the letters seem to be continuous.

A modification of the electric pen is the mimeograph, the mode of using which is as follows: A sheet of thin waxed paper is placed over a steel plate, which is roughened like a very fine file, and presents a surface of very sharp points. The operator writes on the prepared paper with a smooth steel-pointed tool, or stylus, and then perforations are made, and, by means of an ink roller, as many as two thousand copies can be duplicated from it, all of them exquisitely legible.

But certainly one of the most astonishing inventions of Edison's is telegraphy from a moving train. When this is done no extra wire is used, but the air alone acts as a medium for carrying the electrical currents from the train apparatus to the ordinary telegraph wires running by the side of the line. With Edison in this successful work is incorporated the name of Phelps; and Messrs Gilliland and Smith had also worked at the invention.

The great distance travelled by railway passengers in America, and the frequent need of sending a message after a traveller, already on his way, has caused inventors to ponder over the desirability of telegraphing to and from trains in motion.

The principle upon which the inventors have worked has always been the same: they have taken advantage of the law of electrical induction, by which a current sent through a wire creates a sympathetic current in a wire parallel to

it. Thus, if an insulated wire be laid down between the metals of a track, and one of the carriages of a moving train be wound round with coils of wire, which act as an inductive receiver, a message sent along the track wire will jump the interval between it and the carriage in question, and be received by the operator in the carriage of the moving train, who will at once convey it to the passenger who sits in the seat the number of which is indicated on the telegram.

Afterwards a distinct improvement was made by the inventors in elevating the conducting wire from the tracks upon short poles by the side of the line—about ten or twelve feet from the line. The poles are much shorter than ordinary telegraph poles, being from ten to sixteen feet high. And now, whenever practicable, the metal roof of the carriage is employed as the inductive receiver; but where no metal roof exists, the plan is to attach a wire to the roof, which wire is placed under the eaves of the carriage. As the operator sits in his carriage, receiving and transmitting the message, a battery of twelve small cells is by his side for the transmission of messages, a small tablet is on his knee to which the key, the coil, and the buzzer are attached, and there is just sufficient surface to hold a telegraph form. A telephone is fixed under his cap and pressed closely to the ear. The buzzing message just arrived from a distant station left by the train some time before is broken up into Morse characters by the key, and he writes it on the telegraph form before him.

On the occasion of a trial, some years ago, Colonel Gouraud sent the following despatch from a moving train to Mr Pender, in London, *viâ* the Atlantic cable :

'I am telegraphing these words while comfortably sitting in a car of the Lehigh Valley Railway Company, flying

through the beautiful valley of that name, at a rate of something more than sixty miles an hour, by that marvellous system invented by Edison and Phelps, known as the induction telegraph, there being, of course, no wire connecting the train with continuous telegraph wires over which the message is now passing, the current jumping from the car to the wires, a distance of twenty-five feet. We are telegraphing in this way to any or all trains on the railway, each train being equally in connection with the train despatcher. This is the first message sent in this manner from America to England. A large party of representative telegraphists and scientists are the guests of the Consolidated Railway Telegraph Company, amongst which are many of your American friends, including Mr Edison and President Cheever.'

CHAPTER XII.

THE PHONOGRAPH.

LIKE a fairy tale reads the further history of Edison's most wonderful and wonder-working inventions, one of the chief of which is the phonograph, an instrument invented in the spring of 1877, at the Menlo Park laboratory, for recording and reproducing human speech and songs, &c.

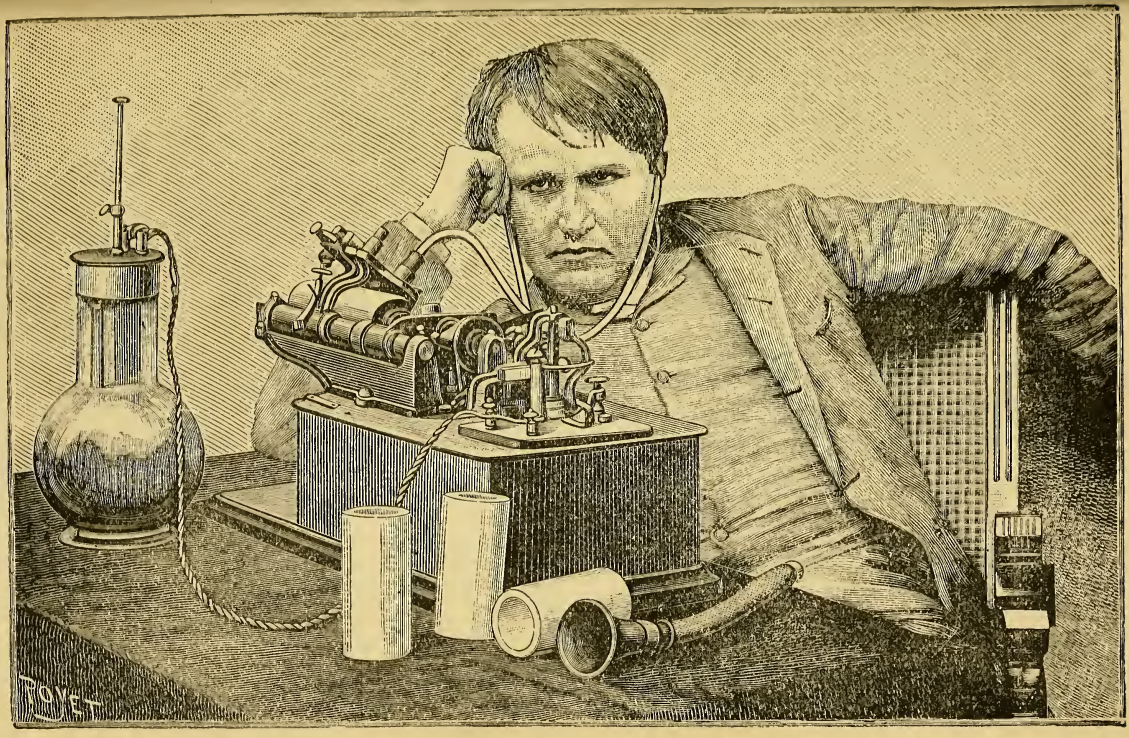
Long years before, Lieutenant Maury, the distinguished student of storms and winds, writing to a friend about the invention of photography, said, 'What a pity it is that M. Daguerre, instead of photography, had not invented a process of writing by merely speaking through a trumpet at a piece of paper! Instead of saying, 'I wrote you a

letter last Monday,' the phrase would have been, '*I spoke you a ream.*' Edison had not read this letter, which had not then been published, when he began the experiments that resulted in his famous phonograph.

In those early days when such an instrument as the phonograph was a mere possibility, based on the crudest of material foundations, Edison, speaking of the instrument he fain would create, wrote words which proved to be prophetic: 'This tongueless, toothless instrument, without larynx or pharynx, dumb, voiceless matter, nevertheless mimics your voice, utters your words, and centuries after you have crumbled into dust, will repeat again and again to a generation that could never know you, every idle thought, every fond fancy, every vain word that you choose to whisper against this thin iron diaphragm.'

After all, it was by accident that he discovered the principle on which he made his phonograph. Busy with experiments about the telephone, 'I was singing to the mouth-piece of a telephone,' he said, 'when the vibrations of the voice sent the fine steel point into my finger. That set me thinking. If I could record the actions of the point, and send the point over the same surface afterward, I saw no reason why the thing would not talk. I tried the experiment first on a strip of telegraph paper, and found that the point made an alphabet. I shouted the words, "Halloo! halloo!" into the mouth-piece, ran the paper back over the steel point, and heard a faint "Halloo! halloo!" in return. I determined to make a machine that would work accurately, and gave my assistants instructions, telling them what I had discovered. They laughed at me. That's the whole story. The phonograph is the result of the pricking of a finger.'

His friend Batchelor was sceptical about the success of



EDISON WITH HIS PHONOGRAPH.

the new venture, and laughingly bet him a barrel of apples that he could not make the thing go. Edison, however, made a drawing of a model, took it to Mr Kreusi, who was then assisting him, and told him it was a talking machine. He smiled, thinking it was a joke, but set to work and soon had the model ready. Then Edison arranged some tinfoil on it, and spoke into the machine. Kreusi looked on, still laughing at it. 'But when,' said Edison, 'I arranged the machine for transmission, and we both heard a distinct sound from it, he nearly fell down in his fright. I was a little scared myself, I must admit. I won that barrel of apples from Batchelor, though, and was mighty glad of it.'

The facts of the case were these: Following up some of his telegraph inventions, Edison had developed a machine, which by reason of the indentations made on paper, would transfer a message in Morse characters from one circuit to another automatically, through the agency of a tracing-point connected with a circuit-closing device. Upon rapidly revolving the cylinder that carried the indented or embossed paper, Mr Edison found that the indentations could be reproduced with immense rapidity through the vibrations of the tracing-point. Then he saw at once that he could vibrate a diaphragm by the sound-waves of the voice, and by means of a stylus attached to the diaphragm make them record themselves upon an impressible substance placed on the revolving cylinder. The record being thus made, the diaphragm would, when the stylus again traversed the cylinder, be thrown into the same vibrations as before, and the actual reproduction of human speech or any other sound would be the result. At first the invention thus thought out was tried with paraffined paper as the receiving material, and afterwards

with tinfoil. The records were made on soft tinfoil sheets fastened round metal cylinders. By-and-by, however, a light tube of wax to slide on and off the cylinder was substituted for the tinfoil which had been wrapped around, and the indenting stylus was replaced by a minute engraving point. Under the varying pressure of the sound waves, this point or knife cut into the tube almost imperceptibly, the wax chiselled away wreathing off in very fine spirals before the edge of the little blade as the cylinder travelled under it. Each cylinder would receive about a thousand words. In the improved machine Edison at first employed two diaphragms in 'spectacle form,' one to receive and the other to reproduce, but he has since effectively combined these. The wax cylinders can be used several hundred times, the machine being fitted with a small paring tool, which will shave off a record that has been used, leaving a smooth new surface. The machine has also been supplemented by Edison with an ingenious little electric motor, with delicate governing mechanism, so that the phonograph can be operated at any chosen rate of speed, uniformly. This motor gains its energising current either from an Edison-Lalande primary battery, a storage battery, or an electric-light circuit.

Infinite pains were bestowed by the great inventor on the finer shades of sound repetition. Aspirates and sibilants (letters making a hissing sound, as *s* and *z*, are called sibilant), for instance, taxed his patience exceedingly. With his usual disregard of the need of resting when bent upon succeeding, Edison, we are told, often spent from fifteen to twenty hours a day, for six or seven months together, in repeating such a word as Spezia into the stubborn surface of the wax. 'Spezia,' he would say

repeatedly in a loud voice. 'Pezia,' lisped the phonograph, like a shy little girl. And so on for thousands of times, until at last the tube gave back the desired result, and Spezia was properly pronounced.

It must have been droll to hear the revered man of science, with his many honours and wide-spread fame, gravely repeating, over and over again, such infantile rhymes as,

'Mary had a little lamb,
A little lamb, *lamb*, LAMB,'

with emphasis, into his tube.

From the very first, even as made with the crudest apparatus, the success of the phonograph was marked. It has been the centre of interest in every exhibition which has taken place since 1878, and most of the distinctions conferred upon Edison have been given him in connection with it.

In the French Exhibition of 1878, the daily concourse of people attracted by the phonograph alone was estimated at 30,000. Forty-five phonographs were shown, and men of all nationalities heard their tones reproduced in them. 'Never before,' it was said, 'was such a collection of the languages of the whole world made. It was the first linguistic concourse since Babel times.'

The late President Carnot and his family, Mr and Mrs Gladstone, the Prince and Princess of Wales, the Prince of Monaco, Buffalo Bill, and De Brazza, the famous African explorer, were some of those present on this occasion. The last-named gentleman was hopeful that the phonograph would be of great use in Southern Africa, in the way of recording treaties made with tribes who possess no written alphabet, and therefore cannot preserve them in any other way.

An amusing incident occurred at this exhibition. One of the Sioux braves, in the following of Buffalo Bill, was asked to speak into the phonograph, which he proceeded to do with great gravity. But when he heard his familiar gutturals repeated to him again, he was greatly alarmed, and throwing his tubes down, sprang back some paces, with looks of terror. The poor fellow would have it that he had heard the voice of the Great Spirit, and his fellow-Indians could not be induced to come within twenty feet of the phonograph.

The mode of using the phonograph is quite simple. It is only necessary to talk into the receiver in a natural tone of voice, and in one's usual manner, after which the phonogram, as it is called, is taken from the phonograph and enclosed in a little box. The recipient of the phonogram places it in his apparatus, and then setting the machine in motion, hears the familiar voice of his correspondent speaking to him.

The first phonogram in this country, a private letter of Edison's to his representative, Colonel Gouraud, of Upper Norwood, was received on the occasion of a party which had been assembled at his house 'to meet Mr Edison.' When the little cylinder was placed in the machine awaiting it, Mr Edison's voice began to speak, with the most startling effects upon those present, even the children recognising the tones of the inventor's voice.

An amusing phonogram addressed to the London press, began, 'Gentlemen, in the name of Edison, to whose rare genius, incomparable patience, and indefatigable industry I owe my being, I greet you. I thank you for the honour you do me by your presence here to-day. My only regret is that my great master is not here to meet you in the flesh as he is in voice,' and so on.

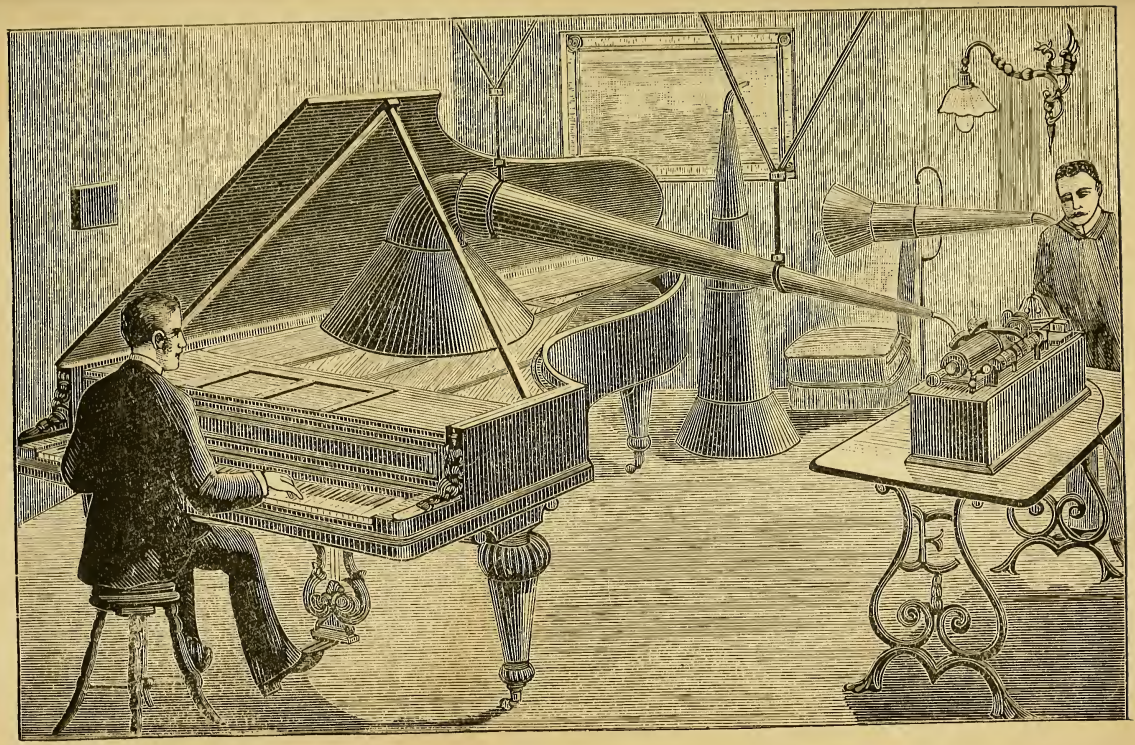
This phonogram, together with several others, was exhibited by Colonel Gouraud at the Crystal Palace in 1888. Several musical pieces were also given, from a whistled operatic air to a cornet and piano duet.

Here several distinguished men availed themselves of Edison's permission to talk to him, and early in the following January he received several cylinders, enclosed in a little

Transmitting Cornet Solo in the Phonograph.

oak box, containing speeches to him by Gladstone, Sir Morell Mackenzie, and others.

Gladstone's words were: 'I am profoundly indebted to you for not the entertainment only, but the instruction and marvels of one of the most remarkable evenings which it has been my privilege to enjoy. Your great country is leading the way in the important work of invention.



TRANSMITTING PIANO SOLO IN THE PHONOGRAPH.

Heartily do we wish it well; and to you, as one of its greatest celebrities, allow me to offer my hearty good-wishes and earnest prayers that you may long live to witness its triumphs, in all that appertains to the well-being of mankind.'

Queen Victoria also sent a message to the inventor by means of one of his phonograms, in very gracious terms. Henry Irving and others sent their congratulations, or messages of approval, and songs and tunes were sent off to him in America. During the Handel festival of 1888, a huge horn which was placed in the press gallery of the Crystal Palace concert-room, gathered up the volume of sound from four thousand voices, the powerful organ and orchestra playing and singing Handel's *Israel in Egypt*, all which was in America afterwards reproduced by the phonograph, in the most wonderful way, before large audiences of people in America's largest cities.

Edison himself said the phonograph would be found useful for letter-writing, the teaching of elocution, the reproduction of music, and the family record, which would preserve the sayings, reminiscences, and so on of members of a family in their own voices, and the last words of dying people. Also it would be useful for musical boxes and toys, clocks that should tell the time in speech, and for educational purposes, so preserving the explanations made by a teacher that his pupils can refer to them any moment; or spelling and other lessons could be put on the phonograph, and committed to memory afterwards at the convenience of the learner. Again, in connection with a telephone, it would be of use so as to make that invention an auxiliary in the transmission of permanent and valuable records. And he adds another use which seems to me to be particularly pleasing and beneficial: phonographic

books could be made which would speak to blind people without any effort on their part. Not only have these claims of Edison's been more than substantiated, but each year brings forward more uses for the phonograph than even those thought of by the inventor's fertile brain. The phonograph has been found helpful in restoring the deaf, by stimulating the dormant functions of their ears by means of the vibratory force conveyed from the cylinder of the phonograph.

Perhaps, however, the prettiest use to which the phonograph has been put is in the matter of children's toys. By inserting miniature phonographs in dolls, they are made to say nursery rhymes, or coo, or cry very like a real baby.

The Queen of Holland was presented with the first three of these accomplished dolls, to the no small delight of the royal nursery.

The demand for these phonographic playthings has been so great that the Edison Phonograph Toy Company has been formed, which has turned over an immense amount of money. The dolls' bodies are made in European factories, and then they are sent to the Orange phonographic works at New Jersey, to be fitted with the tiny phonograms.

As for the application of the phonographs to clocks, this has been done at Edison's own house so successfully, that a guest of his was terribly alarmed by being awoke out of sleep in the night with the words spoken in a loud sepulchral tone of voice, 'Midnight has struck,' followed by the solemn words, 'Prepare to meet thy God.'

The hapless visitor rose and fled into the passage, where he met the inventor himself, who mildly remarked, 'Don't be scared, old man; it's nothing but the clock.'

Very general has become the use of the phonograph in many business ways; several thousands are distributed amongst American business-offices, where they facilitate correspondence. They are also employed by stenographers as a help in the transcription of their shorthand notes. Heretofore, these notes have been slowly dictated to amanuenses, but they are now frequently read off to a phonograph, and then written out at leisure. The phonograph is, however, being used for direct stenographic work, and it reported verbatim forty thousand words of discussion at a convention held in 1890, the words being quietly repeated into the machine by the reporter as quickly as they were uttered by the various speakers.

A large number of phonographs are in use by actors, clergymen, musicians, reciters, and others, to improve their elocution and singing. Automatic phonographs are probably familiar to us all, as they are to be found in many places of public resort, equipped with musical or elocutionary cylinders, which can be heard on the insertion of a small coin. The value of the phonograph in the preservation of dying languages has been proved, too, and records have already been secured of the speech, songs, war-cries, and folk-lore of American tribes which are becoming extinct. Several voice records, also, remain to us yet of distinguished men, who 'being dead, yet speak.' Their tones can now be renewed at will, and their very utterances can be heard again and again through all time. The machine in a more or less modified form is also being used to furnish a record of communications made through the telephone.

Large sums of money have of course accrued to Edison from the immense success of this single unique machine.

CHAPTER XIII.

ELECTRIC RAILROADING.

'DO you want to see my novel?' Edison asked a writer of fiction one day, after the latter had given him some of his books.

'Yes,' was the somewhat wondering reply.

The great inventor at once took out of his desk a short but very thick blank book, and, turning the pages, displayed a number of rough sketches, accompanied by pencil notes. The sketches were plans or general outlines of mechanical contrivances, each of which had a page by itself, and the date when it was scribbled. Nearly every day in a month was represented by some such entry.

'These ideas are occurring to me all the time,' said Edison. 'Some of them are for new inventions, others are proposed improvements in existing machines—both other people's and my own machines. I just dot them down here whenever they strike me, day or night, and keep them with the hope of getting leisure to develop them.'

Electric railroading was one of the earliest branches of locomotive science Edison experimented with. One day, with a view to making a mountain-climbing electrical railroad, he was busy experimenting with a car, in which rode a small boy, on a track he had built on a down grade at an angle of forty degrees, using grippers to catch the rail. All at once, however, his grippers broke, and the car

rushed down the hill so rapidly that the small boy was in danger of being killed. That checked the experiments in that line.

Very different and much more practical, however, was the line of electric railroading which was set up at Menlo Park, and carried out with considerable success later on. The current was furnished from the laboratory, and passed into the rails, which were pitched for insulation from the ground. Entering through one rail and passing up through the wheels, which were insulated from the shaft, the current passed thence to the motor and out through the other wheel. The motor was simply one of Edison's dynamos.

An amusing story is told of Edison's having a little fun —in all his arduous toils he never lost his boyish love of fun—at the expense of the directors and shareholders of the line, when he invited them to go upon a trial trip. After the customary greetings and civilities, the gentlemen took their seats, with the anticipation that, first of all, they would hear a proper scientific explanation from Edison of the new system. But their serious demeanour and solemn faces upset Edison's gravity entirely. Without one word to prepare them for it, he suddenly turned the motive power on to his line in all its force. Faster and ever faster, at the rate of forty miles an hour, flew the engine; greater and greater grew the terror of the passengers. The directors' hats were carried off, their coat-tails fluttered in the breeze, and agonised entreaties to him to stop the engine were to be heard. But Edison, for a little while, only increased the speed.

Shortly after that, the inventor found that he had two rivals in electric locomotion, Messrs Siemens and Field. When the matter was tried in court, the claims of Siemens were dismissed, and Edison effected a consolidation with

Mr Field, which led to the establishment of the United States Electric Railway Company.

At the Chicago Exhibition, soon afterwards, their first electric railroad was shown to the world, and their electric locomotive, which was called 'the Judge,' was greatly admired. During the thirteen days whilst it ran to and fro upon the limited line of about one-third of a mile, it carried 28,805 passengers, and made 1588 trips. Afterwards it was taken to the Louisville Exhibition, where an electric railroad was prepared for it, and there, too, it won immense applause.

Now there is brisk and extensive locomotion going on in different places, and it is but a question of time when the work of the steam locomotive will fall to the electric car. The latter is now supplanting steam in the long tunnel under the city of Baltimore, where whole trains, both luggage and passenger, are drawn along, six or seven miles, by powerful electric motors. The engineers studying the gradual details of electrical locomotion are still uncertain whether the better plan will be to have a separate locomotive drawing the train of the future, or whether each carriage or truck is to be furnished with its own motor.

Mr Lenier says that the possible speed is to be limited only by the problems of the cohesion of steel in the rails and engines. He asked Mr Edison what in his opinion was the practical speed limit on the horizon of electrical locomotion, and he replied, 'Perhaps one hundred and fifty miles an hour.' But he believes that before we come to moving heavy trains by electricity—to which there are serious, although not insuperable obstacles—we shall shoot our mail through the country by some electrical device of telpherage construction.

CHAPTER XIV.

ELECTRIC LIGHT.

UPON being asked which of his inventions caused him the greatest amount of study, and needed the most elaborate experiments, Edison promptly replied, 'The electric light; for although I was never myself discouraged, or inclined to be hopeless of success, I cannot say the same for all my associates.'

And then he went on to say that, through all those years of experimenting and research, he never once made a discovery. All his work was deductive, and the results achieved were those of invention pure and simple. He would construct a theory, and work on its lines until he found it was untenable. Then it would be discarded at once, and another theory evolved. This was the only possible way in which he could work out the problem, for the conditions under which the incandescent electric light exists are peculiar and unsatisfactory for close investigation.

'Just consider this,' he said. 'We have an almost infinitesimal filament, heated to a degree which it is difficult for us to comprehend; and it is in a vacuum, under conditions of which we are wholly ignorant. You cannot use your eyes to help you in the investigation, and you really know nothing of what is going on in that tiny bulb.' He had made *three thousand* different theories, he continued, in connection with electric light, each of which seemed reasonable and likely to be true. Yet in only two cases had his experiments proved the truth of the

theory. His chief difficulty was in constructing the carbon filament, the incandescence of which was the source of light. Every quarter of the globe was ransacked by his agents, and all sorts of the queerest materials were used, until, at length, a peculiar shred of bamboo was fixed upon.

From the time of Sir Humphry Davy's first practical contribution to the science of electric lighting in 1812, men of science had repeatedly striven to perfect and make practicable the electric light. They had been baffled by many difficulties; amongst these, notably that of great expense, and also of the short duration of the lights when obtained. The celebrated Jablochkoff candles, for instance, only lasted a few hours.

Then Edison took the matter up in his persevering and masterly way. First, he made an incandescent solid, which was a great success. Then, on the 16th of October 1879, he and Mr Batchelor were hard at work, trying to make a carbon filament into a lamp. A cotton thread was first taken, and a peculiarly shaped groove just wide enough to hold the thread was cut in a nickel plate, which was placed in a small nickel mould and filled with charcoal. For five hours they carbonised and cooked the mould. But upon Mr Batchelor's taking it out of the groove, it at once fell to pieces.

The experiments were repeated, neither man going to bed on the nights of the 16th and 17th. On a late hour of the night of the 18th, a filament was rescued intact; but it unfortunately broke as they were securing it to the conducting wire.

With characteristic indomitableness, Edison suggested that they should make a lamp before they slept, or perish in the attempt.

To this Mr Batchelor agreed, and work was resumed. At last, on the morning of the 20th, a perfect specimen was obtained. But, alas! in carrying it from the laboratory to the glass-blowing building, a slight breeze whirled it from its fastening and blew it to a powder.

'Edison, it's gone—broken by the wind! I'm sick, I'm disgusted!' cried poor Mr Batchelor, worn by fasting and sleeplessness.

On the 21st, however, a lamp was completed, lighted, and eagerly watched by thirty experimenters. Then Edison and Batchelor allowed themselves to sleep for a few hours. When they awoke, they found, to their satisfaction, that the lamp was still burning. For several days it burnt on, until, at length, the soft glow faded. This was the first specimen of the Edison incandescent light.

In great excitement at the success of that first lamp, thirty or more of Edison's assistants set to work at once to try to carbonise every material which seemed likely to yield the necessary amount of carbon. A graphic picture is drawn us by Edison's biographers, of the eager, hard-working men in the great workshop, toiling until they were perforce obliged to lie down and sleep anywhere, on bench, or floor, or table, just as it happened; others working on, meanwhile, with bloodshot eyes and tense brows.

'These were the pioneers of the electric light,' said Edison; 'and to their faithful labours is due the wide-spread introduction of the system.'

Whilst Edison was still experimenting in the endeavour to find a filament which would answer his purpose better than the one which had with such difficulty been made to do duty for the first specimen of incandescent light, he remembered a passage in Humboldt's writings which

described the properties of a certain kind of bamboo that grew on the banks of the Amazon. As he more closely examined this description, he became convinced that in vegetable fibre alone could be found the exact material for which he had been so long looking. After that, therefore, he sent from time to time chosen emissaries to far-distant lands, to find out if possible where grew the particular kind of bamboo which would best answer his purpose.

Mr William Moore was the first discoverer of the required bamboo, which he found for Edison in the year 1880. This gentleman travelled in China and Japan, and was eminently successful in his search for the fine fibre of the bamboo, which he found furnished a conductor of the requisite resisting power for the incandescent lamp. This fibre is still in use, nothing better having been as yet discovered.

Not being certain, however, that there was no superior bamboo for the work, Edison, as we have seen, sent out others to make still further investigations. Mr McGowan, a gentleman of Celtic birth, and consequently energetic and enterprising, went off to search the vicinity of the Amazon, which he accordingly did for two thousand three hundred miles, in spite of dangers from wild beasts, reptiles, fevers, and predatory Indians. He explored the great continent from the Atlantic to the Pacific, passing through districts so beset by wild beasts, and so heavy with poisonous exhalations, that they were avoided even by the natives. For one hundred and sixteen days he tasted no meat, and did not change his clothes for ninety-eight days.

'I'll make the trip, do my duty or die,' he said boldly, to those who tried to dissuade him from penetrating into particularly dangerous regions.

On one occasion he was deserted by all his Indian followers but one faithful man, who would not leave him. Another time, when he, with a fresh band of Indians, was busily searching for bamboos about five miles from the Napo River, they all had a tremendous fight with a 'tiger' or jaguar. Many varieties of bamboo were found by this indefatigable explorer, of many different sizes—in some places they never exceeded four inches in diameter, or forty feet in height, and in others they grew from six to nine inches in diameter and from seventy-five to a hundred feet in height.

Not long after his return from this satisfactory expedition, McGowan suddenly and mysteriously disappeared. Search was made for him, but in vain; no trace of him could be discovered. It was then thought that he had either been taken suddenly ill and died before he could communicate with his friends, or else that, in his American travels, he had fallen in love with some beautiful native maiden, for whose sake he had for ever left the more civilised though less poetically beautiful regions of mankind.

Still unsatisfied as to what further might remain to be discovered in other quarters of the globe, Edison determined, much later on, to despatch an explorer for bamboo to Ceylon, the Indian peninsula, and adjacent countries. With his usual skill he chose an able man.

Mr Ricalton, the school principal of Maplewood, N.J., was busily engaged one day in his schoolroom, when he received a note from Mr Edison, requesting him to be so good as to come and see him. Wondering what the Wizard would require of one in the scholastic line, the schoolmaster, at the appointed time, entered the inventor's great laboratory, and was conducted to his presence.

'You like travel, I believe?' was Edison's first remark.

'Rather,' replied the schoolmaster.

'I want a man to ransack the world for a fibre; how would you like to undertake that?' was the next question.

'That would suit me,' said Mr Ricalton.

'How soon could you start?' asked the other.

The schoolmaster said he must first get permission from the Board of Education to vacate his position as principal of the school. The Board would have to procure a substitute for him, and then he would require a little time for preparation.

'Oh, I want you to start to-morrow,' said the great man.

'But, Mr Edison, I must have a little time; you want me to search the world—the world is large, and I have buttons to sew on,' remarked the other humorously.

'Well,' rejoined Edison, 'it is somewhat of an undertaking. It may take you three years, and you may succeed in six months; so lose no time in securing a leave of absence, take a week or two for preparations, come to my laboratory daily during that time for experimentation; when you have completed your experimental work, go into the library and study the flora of the tropics; learn the habits of every species of bamboo,' and so on. Edison agreed to prepare him meantime a complete outfit of tools for testing the fibrous products of the tropics.

Two weeks of preparation were spent in this way, and then, having obtained the necessary leave of absence from the Board of Education, Mr Ricalton sailed for India.

In Ceylon, where he visited every part of the island, he found the most magnificent species of the bamboo family, although, he says, it is a native of Burma. It is called the giant bamboo, and clumps of from one hundred to two

hundred may be seen, reaching to a height of 120 feet, and measuring from ten to twelve inches in diameter. From Ceylon he crossed to India, ascending the Himalayas to an altitude of 6000 feet, where he found some fine specimens of the bamboo family. In Japan, which he next visited, his search was simplified by finding a complete collection of bamboos in the Botanical Gardens and Museum at Tokio. When he left Edison's laboratory, the great electrician placed a sample of bamboo in his hand, saying, 'If you find as good as that, I will be satisfied.' And now, in two localities of the tropical belt through which he passed, Mr Ricalton found fibre which stood a much higher test as a carbon than the sample Mr Edison gave him. But he afterwards found its splitting qualities were not so good. His intention had been to visit Java, Borneo, and the Asiatic Islands, but thinking the two different fibres already found were quite good enough for the purpose for which they were wanted, he set out on his return journey.

Mr Ricalton tells the story of his reception by Edison, when he again reached his laboratory, in the following words:

'The first time I met Mr Edison after my return I shall not soon forget, as showing how ordinarily important things are looked upon as trifles in a mind so fully occupied. I had spent a year in an unusually hazardous search, embracing a circuit of the globe, and entailing an expense that would be a fortune to many a toiler. He was passing through the laboratory on his incessant supervisory work; he extended his hand, smiled, and, with a brief "Did you get it?" hurried on to the thousand-and-one exigences with which his wondrously busy life is filled.'

Mr Edison, he was informed, was then using an artificial carbon, which he expected would supersede the bamboo, and Mr Ricalton never learned whether any practical use was ever made of the fibres he had found.

Edison has never claimed to be the original discoverer of electric light. But he does claim that the desultory and immature principles of his predecessors were by him made into a complete whole. By him the incandescent electric light was taken from its hiding-place in the laboratory, and made of practical utility. Instead of a costly toy, it has become an important adjunct to public life.

In the winter of 1880, at Menlo Park, the first public exhibition of the new electric lamp was given. Special trains conveyed visitors there from all parts of the United States. They came from motives of scientific or commercial curiosity. Seven hundred lamps were distributed in the most effective manner throughout the grounds, streets, and all about the Edison Works. Most of the conductors were laid under ground, much as gas is laid; and thus was demonstrated the inventor's assertion as to the entire practicability of electrical commercial lighting. Cautious capitalists thereupon plied him with schemes for the extension of his methods. A company was formed to work the new incandescent light, and the stock, whose par value was only a hundred dollars a share, rapidly rose until it was three thousand. Newspapers and visitors vied with each other in spreading the tidings of the glorious electric light, which soon became famous and much sought after.

An amusing story is told of a scientific dispute which took place about this time. A certain schoolmaster had been an interested spectator at the Menlo Park illumination, as he had exerted his faculties in following up

Edison's experiments with the electric light; and upon his return to the hamlet (Suffern) in which he lived, and where his word was unquestioned on matters of science and erudition, he was appealed to by the villagers to explain the nature of a brilliant light which appeared in the western sky.

With his mind full of the wonders he had witnessed in the way of electrical lighting at Menlo Park, and with the most credulous belief in the powers of its inventor, the worthy schoolmaster promptly pronounced the new light that overhung the Remapo Mountains to be an electric light. When asked for further explanations, he gave it out that Edison was experimenting with an electric light and a balloon at Menlo Park—forty miles distant—to see how long that sort of illumination would burn in the upper regions of the air. Moreover, he stated that upon the successful issue of this test important results depended, the system being under consideration of government, which was considering it in relation to coast-lighting and signal-service. Now in the little hamlet every one but the post-master assented to this view of the matter. But the post-master recognised in the new light a distinct resemblance to a planet. Public opinion, however, scouted this idea, and the notion that it was an electrical light of Edison's prevailed, until it was proved to be nothing of the sort.

Many tributes, say Mr and Mrs Dickson, have been laid at the inventor's feet, but none which will vie with the above in absolute naïveté of admiration.

At the Paris Electrical Exhibition, soon after, the new Edison incandescent lamp was displayed very extensively, and its inventor became the recipient of five gold medals and a diploma of honour, which was the highest distinction bestowed on any exhibitor.

On that occasion Edison received this cablegram from the official headquarters of the exhibition :

'Official list, published to-day, shows you in the highest class of inventors. No other exhibitor of electric light in that class. Swan, Fox, and Maxim receive medals in class below. The sub-juries have voted you five gold medals, but General Congress promoted you to the diploma of honour. This is complete success, the Congress having nothing further to give.'

Other telegrams, containing compliments and congratulations from men of science, followed. Swan, the proprietor of the Swan Incandescent Light in England, generously cabled : 'You have received the highest award the jury has to give. I congratulate you.'

The new system spread 'like wildfire.' The following year, at the Crystal Palace Electrical Exhibition of London, Edison's light attracted general attention. Mr and Mrs Dickson's description of the display made on this occasion reads like a fairy tale.

'From the glittering coronal of frozen loveliness—meet diadem for the Scandinavian frost giants—which overhung the concert room of the Palace, to the tinted fires which glowed in the heart of fountain, flower, and sward, the eye was intoxicated with beauty. The entertainment court was canopied with a chandelier of the most exquisite design, the work of Messrs Verity & Co., gathering into itself the floral magnificence of a hundred favoured climes. Metal and coloured glass combined in the reproduction of nature's softest and richest hues, and a tiny spark, concealed among the petals, or nestling beneath the folded leaves, brought into relief each delicate curve and vein. Three hundred and fifty of these fairy blossoms were represented, ranging from the sunflower, the narcissus, the

tiger-lily, and the orchid, down to the modest pink, the whole enshrined in a basket of hammered brass. Ninety-nine Edison lamps in three circuits were employed, the brass stems of the flowers being hollow, so as to admit of the passage of the wires.'

Mr Edison presented a miniature model of this chandelier, or electrolier, to the Prince and Princess of Wales. Upon it was the inscription: 'A souvenir of the visit of their Royal Highnesses the Prince and Princess of Wales, to the Electrical Exposition of the Crystal Palace, 1882; with the compliments of Thomas Alva Edison.' Electricity, we are told, was stored within the recesses of the bouquet, so as to be instantaneously brought into play or extinguished.

The press vehemently expressed its admiration. The *Illustrated London News* commented on the soft delicious radiance which came from the new Edison lamp, saying that its soothing influence had quite neutralised the popular objection to electricity for indoor illumination. Finally, it said, the Edison exhibit was unique, and well merited the praise bestowed upon it.

'The palm is undoubtedly carried off by the Edison show, which is extremely beautiful,' said another periodical.

'Mr Edison's splendid show in the concert room and entertainment hall continues to attract more attention than any other,' said a third paper.

At other exhibitions, in Munich, Vienna, Philadelphia, Paris, and Minneapolis, the beautiful, steady, and mellow Edison electric light met with the same admiration and success. And in the Paris Exhibition of 1889, where nine thousand feet were allotted to the inventor, that space was filled to overflowing with the fruits of Edison's inventive

genius. In the centre of all was an immense model of an incandescent lamp, forty feet high, the globe of which was constructed of no less than twenty thousand incandescent lamp bulbs, which brilliantly illuminated the entire building. An enormous dynamo was also shown, and an allegorical picture, entitled, 'Menlo Park, the Birthplace of the Incandescent Lamp.' A series of charts was also exhibited, representing the most important buildings in the world which have adopted the Edison methods of lighting.

More companies, industries, and factories for the working of the Edison light forthwith sprang into being, and grew in strength and magnitude. In 1882 the European Company was organised, plants were set up in important transatlantic centres, and the Edison London Company was formed. Commercial success followed, and this more especially in the States, where the Menlo Park Exposition of electric light had first given fame to the new venture, which had increased more and more as time revealed its excellence.

Edison personally superintended the extension of the factories. The Goerck Street shop in New York was first established, and then another at 65 Fifth Avenue, which became a favourite one of Edison and his earlier associates. A smaller lamp manufactory at Menlo Park followed, together with establishments first begun at Brooklyn, for promoting underground tubing; these establishments were of much importance to the system, and were incorporated under the name of the Electric Tube Company. The Edison Company for Isolated Lighting was launched in 1881, and in 1882 a common source of creative energy for the isolated plants was supplied by the establishment of the Pearl Street Central Station at New York, which

possessed fifty miles of conductors and 2000 lamps. A large factory at Newark, N.J., gave rise to the Edison Lamp Company, which in time caused the place to become known as the 'Lamp Works of the Edison General Electric Light Company.' At the present day this is a large business extending to 25,000 lamps a day.

In 1886 the Edison Electric Light Company and the Edison Company for Isolated Lighting consolidated under the name of the Edison United Manufacturing Company. But in 1889 a still more complete consolidation of the various light and power industries was effected under the name of the Edison General Electric Light Company, with a capital of 15,000,000 dollars, and an annual income of almost the same amount.

Now, for the first time, money poured into Edison's purse, and he knew what it was to have a good independent capital of his own. No longer cramped and harassed by want of means to further his costly schemes, Edison now worked as hard as ever, but with more freedom, at his wonderful inventions.

Some detractors of course Edison has had. Professor Barrett, lecturing in 1879, said: 'Amongst scientific men a very unfavourable opinion of Edison exists, from the sensational reports which have come to us from America. But we must remember that the inventive faculty which is so largely developed in the United States seems of late to have extended to its newspaper reporters. Thus it comes to pass that some persons speak of Mr Edison as if he were a Davy, a Faraday, a Tyndall, and a Roscoe all in one, whilst others regard him as almost a scientific charlatan.'

The attempts of jealous or ambitious people to divert a little of his success resulted in tedious lawsuits, notably

the Sawyer-Mann case, and the Goebal case, which, after occupying much time and entailing heavy costs, were decided in favour of Edison and his light.

In April 1892, when sending Lord Kelvin the record of the litigation in the suits to protect the incandescent lamp, Edison said in his accompanying letter: 'I expect that the already long list of the claimants for the honour of making lighting by incandescence a practical reality, will be still further increased as time goes by.'

Lord Kelvin, in his reply, expressed the sincere hope that the results of the litigation 'will ultimately be all satisfactory to Mr Edison, to whom we owe so much for all that he has done of benefit to the world, not only in electricity, but in other large departments of inventions.'

The inventor's happy disposition has prevented the opposition and jealous detraction of rivals from causing him as much suffering or anxiety as it otherwise would. It was characteristic of him that he should pleasantly assert, when a certain Professor Morton, in the early days of his incandescent light, had been lecturing against it, that, when it was perfected, he would erect a statue to this raven of science, and frame it in the splendour of the new lamps, whilst underneath he would have the words inscribed, 'This is the man who said the Edison light would never work.'

CHAPTER XV.

EDISON AS A WORKER AND EMPLOYER.

'DO you have regular hours, Mr Edison?' inquired an interviewer, Mr Lenier, of him, two or three years ago.

'Oh,' replied the great man, 'I do not work hard now. I come to the laboratory about eight o'clock every day, and go home to tea at six, and then I study, or work on some problem, until eleven, which is my hour for bed.'

'Fourteen or fifteen hours a day can scarcely be called loafing,' suggested the other.

'Well,' replied the great inventor, 'for fifteen years I have worked, on an average, twenty hours a day.'

There is none of the lean and hungry look of the overworked student about him, Mr Lenier tells us. His face, though strongly, even magnificently chiselled, is almost boyish in its smoothness; and in his manner there is that flavour of perfect simplicity and cheery goodwill given only to the very great.

'What makes you work?' asked Mr Lenier of him curiously. 'What impels you to this constant, tireless struggle?' adding, 'You have shown that you care comparatively nothing for the money it makes, and you have no particular enthusiasm in the attending fame.'

'I like it,' was the reply. 'I like it: I don't know any other reason. You know some people like to collect stamps. Anything I have begun is always on my mind,

and I am not easy while away from it until it is finished. And then I hate it.'

'Hate it?' inquired the other, struck by his emphatic tones.

'Yes,' he replied. 'When it is all done, and is a success, I can't bear the sight of it. I haven't used a telephone in ten years, and I would go out of my way any day to miss an incandescent light.'

Then the great man grew eloquent, with righteous anger, about the treatment which the inventor only too often meets with. He said a race of professional sharks had arisen to dispute, with absolute disregard of facts, priority of claim to valuable patents. The better known the patentee, the more liable they were to swarm about with suborned witnesses. Mr Edison had no fault to find with the patent law in the matter, but condemned strongly the practice of the United States in issuing injunctions forbidding an inventor to use his discovery until the case was decided, a period often covering years. He maintained that this worked great injustice to the honest parties to a suit, and that there was no protection in patents at all.

Sometimes Edison's zeal and long hours, whilst busy with some important invention, bore rather heavily upon the more limited endurance of his assistants. Hence, a story is told us, by the Dicksons, of an ingenuous youth, who thought he would shorten the dreadfully long working hours one night by putting the clocks on a little. Accordingly, when Edison woke up after a doze in the intervals of work, he saw by the clocks that it was four o'clock, and immediately dismissed his tired assistants. Upon going home, however, to bed, he noticed that the theatres were just pouring forth their visitors. It was, in fact, precisely eleven o'clock. Edison burst into a hearty

laugh, and took the whole matter in the pleasantest way imaginable.

Mr Johnson, who has been associated with Edison in business for twenty years, says that Edison is genial and even frolicsome, with a temperament which might almost be called boyish. 'In the whole of our connection,' he says, 'and notwithstanding the many strains on his temper, and the injustice which he suffers from unscrupulous business antagonists, we have had but one "difference." That was based on a pure misunderstanding, and has long since died a natural death. My association with him has been of the greatest profit and pleasure to me. Our active friendship will end only with the death of one of us, though our business relations have ceased in the course of the natural ramification of the electric light and power industries, with which I became more intimately identified than did his other laboratory associates.'

Whilst busy with developing machines for generating electrical power, Edison established himself for the purpose at Goerck Street, in the building formerly known as the Etna Iron-works. There, with a chosen band of followers, he worked hard at experimenting on the dynamo.

It was at Goerck Street that the following incidents occurred. One day his men were testing a new type of dynamo, which had been greatly reduced in size, and was giving more light than was anticipated. Delighted with the unexpected electrical energy, Edison started a series of tests to discover how high the dynamo could be run without flying in pieces — experimental work not without danger to those employed upon it.

'Fire up, men; let her go!' cried Edison, ordering more steam, even when the limit of the machine had been reached.

The men stood at a little distance from the dynamo, but now they found it desirable to betake themselves to an adjacent large and solid brick building, where Edison was awaiting reports.

Suddenly came a deafening noise. The main steam-pipe had burst. Nothing worse, however, happened, and Edison was satisfied that the demonstration was scientifically complete.

The Dicksons relate another amusing story of the visit of Sitting Bull and his tribe to the Goerck Street works. One morning, Edison sent word that they were coming, and that preparations were to be made for their visit. At the appointed time they accordingly arrived, on several omnibuses and carriages. Very picturesque they looked bedizened with war-paint and other grotesque adornments, but their faces were very grave and stolid. Solemnly they descended from the vehicles which had brought them, and strutted through the establishment, no look of surprise upon their countenances, and no word or sign escaping their lips.

As in the case of the visit of the solemn-faced directors and shareholders to Edison's first electric railway-line at Menlo Park, this gravity of demeanour on the part of his guests tickled Edison's sense of humour, and caused him to play a practical joke.

Ordering one of his dynamos to be stopped, he ran a wire heavily insulated with cotton, and connected it by both ends to the generating machine. Then he got the Indians to stand close to the wire, which ran along the full length of the main shop, and looked closely at their faces whilst the metallic thread became red hot. Not the slightest interest was shown in the proceedings by the Indians until the burning cotton rose in a cloud, filling their eyes

with its stinging fumes. Then a loud 'Ugh!' broke the silence, and the strangers began to rub their eyes.

Edison himself got some burnt cotton in his eyes, but, in his glee at the success of his experiment he did not care about that.

Although sometimes, in the exigencies of an important crisis in his experimental work, Edison would seem to forget his assistants' need of rest and food, he was not at other times unmindful of their bodily comfort and of their need of recreation after protracted and arduous labours.

A certain brick-sloop which anchored at Woodbridge was often hired by him, and, after supplying her with provisions, fishing tackle, and so on, he would take his men some pleasant excursion, during which his genial kindness would come into full play.

No wonder that he was beloved by his subordinates. He dealt in no scathing rebukes, nor was it his wont to abruptly dismiss a faulty servant. He had great patience with those whose ignorance made them err.

A good story is told about his treatment of a young assistant, a would-be electrical inventor, who was possessed by such a great idea of his own importance that he refused to perform some rough work, which required doing, when they were busy with an important experiment. Edison quietly and with great courtesy apologised for having suggested to him such a thing as manual work. Then, rolling up his sleeves, he proceeded to do the dirty and somewhat fatiguing task himself. The lesson learned then by the youth never required repeating. His master's example would ever rise up before him when he felt indisposed to do what some would call menial work.

Perhaps it was after that experience that for a long time, as Mr Lenier tells us, Edison used to have a test applied

when a new man came to work with them in his laboratory. He was told that he would be required to sweep the floor in the morning—this was, of course, only to try him. But if he bridled up and resented it as an insult, Edison and his associates knew that he would never be of much use as an electrician.

Edison will not allow his devoted followers to be 'sat upon' by outsiders, but ever stands up for them, when they get into difficulties. Upon one occasion one of Mr Edison's assistants, or associates, as they are pleasantly termed, was called on to give the bearings of some intricate electrical problem before a formidable board of inquiry. Perhaps from nervousness, the unfortunate young man made several inaccurate statements. These were pointed out and taken exception to by the members of the board, but the general verdict was waived because Mr Edison supported his protégé.

As soon as the room was cleared, the master turned to his follower, saying, 'Now, here you were wrong about that affair. I saw that at a glance.'

'You did, Mr Edison!' said the other in amazement. 'Then why did you endorse me?'

'Because I wasn't going to let those duffers have the satisfaction of crowing over you, if I could help it,' was the kind reply.

All-night toil is rather exceptional with Edison nowadays, but years ago he often did it. At that time Mr Francis Lathrop went out to Menlo Park to make a portrait of him for a popular magazine. The inventor, he found, had just bought an organ, that playing upon it might relieve the strain of intense study and constant experimenting. Having taught himself to play upon it, he would run out of his private laboratory into the main shop in the middle

of the night, hammer out one or two tunes on the organ with almost ferocious vigour, sit a while for the artist to draw his portrait—talking gaily as he did so—and then, with the slightest possible warning, plunge abruptly back into his room. He was at that time intent upon making the electric light perfect. Wishing to know what were the resources of the earth in the line of platinum, he sent for every book he could obtain which bore upon that point, and had the volumes all strewn about him on the floor, or piled up near the scene of his then occupation, many of them lying open at the page where he had been reading last. One of his recreations, said Mr Lathrop, was to fling himself down among these tomes, and pore over them in the pursuit of some especial inquiry, after which he would go back refreshed to the manual part of his task. The mention of this one little circumstance, he adds, may help to show how Edison succeeds in combining the different branches of his labour—practical investigation and research by means of books. He uses one as a relief from the other, to give himself recreation and dispel fatigue.

'Edison,' says Mr Lathrop, 'is always absolutely himself. He does not present to one's observation a mixture of superficial manners and concealed inner man. His outward characteristics, therefore, are insignificant and worth nothing. He has, in a degree which is literally startling, the power of self-concentration. With him no time is wasted on formalities and conventions, and not an instant is lost in passing from one mood or subject to another. The transition, however, is made with the whole momentum of his mind. He is capable of great jollity and a most charming companionableness. Yet, although he may at one instant be wholly absorbed in a merry chat with his

friends, laughing at their drolleries, and cracking jokes of his own, in the very next instant he will be as completely buried in some abstruse scientific problem.'

Perhaps nothing showed this sudden complete transition of deep interests in his mind, and the mental abstraction to which it gives rise, more than the following incident, which is told us of his first marriage in the early days at Newark.

A friend going past his workshop one night saw a light in his room, and, going to him, found that he was dozing over a problem which there was some difficulty in solving.

'Hullo, Tom,' cried the friend, 'what are you doing here so late? Aren't you going home?'

'What time is it?' asked Edison sleepily, rubbing his eyes and stretching himself.

'Midnight, easy enough. Come along.'

'Is that so?' replied the inventor. 'I *must* go home then. I was *married* to-day.'

We have seen, too, how completely he forgot money matters once, when money was of great importance to him, by allowing his mind to become buried in the complex question of quadruplex telegraphy whilst waiting to pay his taxes, and so lost the sum allowed during the days of grace, because he was unable to state who he was, and for what purpose he was there.

It was whilst he was at Menlo Park, and the public were longing to lionise him, that a moulder came there from Messrs Fowler & Wells, to make a cast of his head for their phrenological collection.

The incident was one which cost Edison some pain and trouble. It took place in the upper floor of the laboratory. The inventor good-humouredly sat down in an arm-chair with a towel round his shoulders as though he were about to be shaved. The moulder having oiled his face and

smeared his hair, mixed the plaster and began to put it on the back of his head, leaving the face and neck uncovered. Pieces of tissue-paper were next put over the eyes and patted to give the form, then little rolls of paper were placed in the nostrils. After this the moulder oiled the edge of the back mould and began to approach the mouth. Later, when the cast was finished, it showed the mouth twitched to one side—the effect of a surprise felt when the artist grasped his hand before the plaster was set.

CHAPTER XVI.

THE ORANGE LABORATORY.

AT last there came a time when even the large premises at Menlo Park were too small for the numerous demands upon them; therefore, in 1886, Edison removed to his new laboratory at Orange, N.J., a huge building at the foot of the Orange Mountains.

There, four smaller buildings are grouped near the laboratory, and the whole is surrounded by a high and thick fence, and a gate which is closed to the public, with the notice, 'Mr Edison, in justice to his work, is compelled to deny absolutely all personal interviews;' and again, 'No permits can be issued to visitors to enter these premises.'

An amusing story is told us of how Edison himself once fell a victim to his own law about this necessary exclusion of the public. One day, when he wished to enter his domain, a new and zealous gatekeeper would not allow him to do so until some one came along and identified him.

Edison, we are told, is really one of the most accessible of men, and it is with reluctance that he thus allows himself

to be protected from a too inquisitive public. But at Menlo Park visitors came so very often that they interfered with work, so that he, at length, said jokingly that he should really have to blow up some one to frighten them away.

'Mr Edison is always glad to see a visitor,' said one of his constant associates, 'except when he is hot on the trail of something he has been working for, and then it is as much as a man's head is worth to come in on him.'

The first room a visitor enters at Mr Edison's Orange establishment is a palatial and luxurious library, containing forty thousand works of reference. This apartment looked somewhat bare and dismal at first, but, on Mr Edison's forty-second birthday, the laboratory staff and workmen lovingly fitted it up with soft Smyrna rugs, pictures, palms, and flowers as a birthday present for him. It is now a delightful and most handsome place for study and mental recreation. The contents of the book-shelves give one an idea of the breadth of thought and sympathy of the self-made and self-taught man of science. He is by no means only a scientific specialist, but can respond and talk intelligently on the most diverse topics.

From the library the storeroom, or stockroom, is entered, which contains the most diverse and miscellaneous assortment of material. Just as Edison, when a lad, brought home to his mother's basement all kinds of rubbish, in the hope that they might come in useful for some of his experiments, so now, as a man, he collects everything, no matter what, which he has the faintest idea of turning to account in any way. Here there are unearthly relics of birds, beasts, plants, and crawling things. Skins of snakes and fishes, furs of fur-bearing animals—some very rare—the skin and teeth of sharks and hippopotami, rhinoceros

horns, fibres of strange exotic plants, all kinds of textile substances, and precious stones.

'That,' said Mr Edison, pointing to a globe enclosing the filament of the incandescent light, 'never would work right, no matter how hard we tried, till the fibre of a particular kind of bamboo was put in.' The phonograph, also, was only perfected after the value of the hard sapphire stone was discovered for several of its parts—the reproducing ball, the recording knife, amongst others.

From the storeroom the lower machine shop is entered, which is devoted to making the heavier mechanism of the dynamos, ore-milling machines, &c., and here there is a noisy clanking and throbbing, as the great metal giants are used. On one side are huge mining drills, on another an array of electric motors, in the centre of the shop, so that the power may be sent in any given direction. The men working here are encased in smuts and grime, and powdered with shining filaments of iron or steel. Rough manual labour is here wielded by sturdy frames, and with imperturbable industry.

In the dynamo room are displayed various kinds of the electric generators.

An elevator takes people up to the second floor, where are to be found the lighter and more delicate machines, such as the phonograph, the kinetograph, the kinetoscope, and other apparatus.

The glass-blowing room is very attractive. There the operator wields the plastic crystal, moulds the fairy spheres, and sends out shining threads. On this floor, too, are the rooms devoted to the development of ideas which as yet are barely sketched.

Edison never tries to keep secret his inventions. Any one can see the work that is going on; he seems to have

no fear of any workman or visitor running off with his ideas. A visitor was once looking over one of his numerous volumes of notes. His companion suggested that he had better not look there, it might be private.

'Oh no, there is nothing private here,' said one of the men, overhearing; 'every one is at liberty to see all he can, and the boss (master) will tell him all the rest. He has taken out more patents than any other man in America, but he never made an attempt in his life to keep anything secret.'

Edison's patience with inquirers is indeed very great. And sometimes he has very ungrateful experiences. One day, for instance, a man was looking over his inventions who wanted to know all about the telephone.

Edison explained it in every particular, and received the usual answers; the visitor saying, 'Yes, I comprehend perfectly; simple enough;' and so on, until there was nothing left to tell him.

'Then,' said Edison, when relating the occurrence, 'you can imagine how I felt when he said, "Yes, Mr Edison, I understand it all, except how the sound gets out again." I thought he had understood it, and he hadn't. I gave him up.'

A very powerful impression is made by Edison when he is seen at work, with his fine gray eyes, dark hair inclined to gray, and his robust though not stout figure, in his roomy but somewhat topsy-turvy laboratory, directing his assistants, who follow his directions with almost reverence.

Mr Johnson tells us that 'he is frank and open to a degree, and despite many a sad experience, as well as oft-repeated expressions of cynicism under the sense of injustice, he is always ready with sympathy and an open hand. When he feels himself injured, he is bitter for a

time, but this passes away, unless fed by the active hostility of an opponent. He is extremely sensitive to criticism of his motives, and is even too apt to interpret a light remark to mean a great disparagement. When he is robbed of money he will easily forget it, but if attainted in any moral sense he becomes relentless.'

We are told that the keynote of his work is commercial utility. He asks himself, when pondering over some new idea that his wonderful inventive genius has evolved, 'Will this be valuable from the industrial point of view? Will it do some important thing better than existing methods?' And if he finds it will, then the next question for him is, 'Can I carry it out?' Not so much is he one in search of truth, as a mighty engine for the utilising and application of scientific truths. He is the greatest inventor of his race.

We cannot expect a man who has for years worked twenty hours a day to care for the conventionalisms of society, and we have seen that Edison, although genial and delightful as a friend, shuns rather than courts the tendency of the world to lionise him. He is a brilliant conversationalist, so society loses much in losing him, but his work and the benefit of mankind gain by his strict adherence to it. He has often been heard, we are told, to express contempt for an inventor who, having produced a single invention, makes a tour of society, to receive its plaudits, and finding the life so agreeable, pursues it permanently, to the destruction of his further ambition.

'I am glad to see that Bradstreet rates your credit at three million dollars' (£616,016), some one remarked to him one day.

'It did not come from my inventions,' he said quickly. 'I never made money as a professional inventor. What

property I own has been accumulated since I began to do business, and manufacture the machines in my own shop. That is the only hope of the inventor. He will starve if he depends upon his patents.'

In fact he has been so robbed by patent agents and unscrupulous lawyers, that it is almost to be wondered at that he has still faith in mankind.

Leaving Edison in his laboratory, perhaps, if it is the hour of noon, sitting with his luncheon basket on his knee; or, if he has been up some nights, dropping into a doze as he sits on a bench amongst his men; or it may be turning anxiously to overlook some important endeavour on the part of an associate, we will pass on to the other departments.

A very interesting one is the lamp test-room, on the top floor, where there are many electric lamps all alight, that they may be watched and studied, with a view to correcting every conceivable defect before they are handed over to the public. Very brilliant is the light given by these shining bulbs; but sometimes, as one looks on, a sort of shiver will run through the illumination, and by the bursting of one, the looker-on is powdered with shining fragments. Very necessary, therefore, is this strict examination before they are given over to the public.

Then there is a hall which is devoted to the exhibition of the several inventions of Edison, and one could linger here for long, studying the various products of his brain and accumulative industry. The collection, however, is not so complete as it was before many of the machines were removed to the Paris Exhibition, and many of the inventions are still unknown to fame.

The lecture hall and the out-buildings next claim attention. In the chemical room Edison may often be found,

draped in an unsightly toga, which, originally brown, is now stained magenta, green, and yellow, the result of many experiments. Surely he has borne a charmed life in the past, or some of the mighty powers with which he deals might have done worse for him than disfigure his toga.

Outside there are the galvanometer department—containing a vast collection of valuable electrical instruments, galvanometers, magnetometers, cathetometers, and so on—the ore-milling experiment-room, and the supplementary sheds; to say nothing of the large and unique photographic rooms, in which was evolved one of Edison's latest wonders, the kinetoscope.

CHAPTER XVII.

THE KINETOSCOPE AND KINETOGRAPH.

'IN the year 1887,' says Mr Edison, 'the idea occurred to me that it would be possible to devise an instrument which should do for the eye what the phonograph does for the ear, and that, by a combination of the two, all motion and sound could be recorded and reproduced simultaneously.

The germ of the idea came from the little toy called the zoetrope (wheel of life), and, in working upon it, Mr Edison was but carrying out what Muybridge, Marie, and others had begun.

So successful has been the result of the countless experiments Edison has made, that the kinetoscope, as the device is called, is now an accomplished fact.

The kinetoscope is now on view in London, and of it the *Times* says: 'This instrument is to the eye what

Edison's phonograph is to the ear, in that it reproduces living movements of the most complex and rapid character. To clearly understand the effect, it is necessary to explain the cause, but to appreciate the result—the working of the invention—it must be witnessed. The moving and apparently living photographs in the kinetoscope are produced in the following manner: Mr Edison has a stage upon which the performances he produces are enacted. These performances are recorded by taking a series of forty-three photographs in rapid succession, the time occupied in taking them being one second only. Thus every progressive phase of every single action is secured, and the photographs are successfully reproduced on a film of celluloid the length required for a given scene. When this film is passed before the eye at the same rate of speed as that at which the photographs were taken, the photographically disjointed parts of a given action are united in one complete whole. Thus, supposing a person to be photographed taking off his coat, as is done in one case, the successive views representing the phase of action at every forty-third part of a second are joined up, and the complete operation of taking off the coat is presented to the eye as it would appear in reality. In other words, the kinetoscope is a perfect reproduction of living action without sound. . . . One scene represents a blacksmith's shop in full operation, with three men hammering iron upon an anvil, who stop in their work to take a drink. Each drinks in turn, and passes the pot of beer to the other. The smoke from the forge is seen to rise most perfectly. In another view, a Spanish dancer is shown going through her graceful evolutions, as is also Annabella in her serpentine dance.'

As for the kinetograph, it bears the same relation to the kinetoscope as the recording diaphragm of the phonograph

does to the reproducing diaphragm. The kinetograph is in part a photographic camera, so constructed with attachments and devices that it records forty-six distinct and separate views of moving objects, or scenes, during each second of time. These photographs are recorded on a long film which is finished substantially as all photographs are finished, and is thus prepared for reproduction and exhibition by means of the kinetoscope. The kinetoscope is in the shape of a handsome hardwood cabinet, about the size of a phonograph cabinet, and contains a mechanical device, operated by electricity, which is so constructed as to run the films (containing the views photographed by the kinetograph) past a given point, at a speed of about forty-six every second of time. The films pass over a series of rollers, which keep them steady and secure accurate results. On the top of the cabinet is a small window covered with clear glass, under which is a magnifying lens. If we look through this window, the film passes before our eyes with such rapidity that we see one continuous view, with all the characters moving and acting upon it.

Mr Edison says: 'I believe that in coming years, by my own work and that of Dickson, Muybridge, Marie, and others who will doubtless enter the field, a grand opera can be given at the Metropolitan Opera House at New York without any material change from the original, and with artists and musicians long dead.'

And when a picture of Niagara Falls, for instance, is put before us, the noise of the waters may also be conveyed to our ears by the phonograph; and, in the same manner, the gestures and intonation of some of our public speakers may thus be given.

'We are progressing, progressing,' said Edison, when

visited by an interviewer intent upon learning more about the wonderful kinetograph from the great electrician himself, who is still at work upon it, with a view to further improvements. 'The object of the machine is to afford the spectator two inventions in one—that is, two senses are simultaneously appealed to. Suppose, we will say, an opera is to be reproduced. The phonograph already repeats the sound; the kinetoscope affords a view of the movements. Now, however, we wish to combine the two, and combine them far more effectively than ever their distinct elements have heretofore been rendered by separate instruments. Thus, if one wishes to hear and see the concert, or the opera, it would only be necessary to sit down at home, look upon a screen, and see the performance reproduced exactly in every movement, and at the same time the voices of the players and singers, the music of the orchestra, the various sounds that accompany a performance of this sort, will be reproduced exactly. The end attained is a perfect illusion. One really hears and sees the play if the conditions precedent to the suitable impressions upon eye and ear are obtained.'

'Can ordinary sights and scenes, the Pope in the Vatican, or a speech at a mass meeting, be as effectively handled?'

'Far more easily,' replied the great electrician; 'that is the least difficult part of the problem. Even now the spectator could be treated to a perfect reproduction of Gladstone making a speech to the House of Commons. This would be shown life size, and so far as the spectator is concerned would be the real scene. For every word, every gesture of the grand old man, the gestures of each spectator, and the sounds made on the occasion, would be reproduced exactly. And of course two hundred years

hence the same scene could be thrown up at will—a new way of recording history, you see.'

The journalist asked if the mechanism of such a machine would not be very complicated.

'Not more so than that of the kinetoscope and the phonograph,' was the reply, 'and the difficulty now in the way is the adjustment of the photographic apparatus in minute fractions of a second. Certain flashes of motion are caught in ten forty-ninths of a second. But in preserving them, and in their reproduction, one or two obstacles are met with. The negative itself is very small—not much larger than your thumb nail. In reproducing these postures and movements, great care is necessary in maintaining proportions. To throw upon a screen a series of movements, each taking up an interval of time not longer, perhaps, than a fifth part of ten forty-ninths of a second, and at the same time to ensure fidelity, is the problem. As it is, there are occasional distortions. If a movement in the reproduction be not, so to speak, run out consecutively—that is, if, looked upon as a change of posture, it be not accurately photographed, although it occupied but the two-hundredth part of a second—the effect will be distorted. Hence the extreme nicety required in the mechanism.'

After a pause: 'Perhaps by to-morrow,' continued Mr Edison, 'we may perfect the machinery. Perhaps we shall have to work another year upon it. In truth, it is a simple matter. It consists merely in adjusting thoroughly understood principles to a new contrivance which is made up of old contrivances. Were it not that we have such infinitely small sections of time to deal with, there would be no difficulty at all. But, as I have told you, we know how to overcome the difficulty. We simply lack practice.'

A little more discussion about details followed, and then Edison said: 'I have no doubt whatever of the outcome. Before many years we will have grand opera in every little village at ten cents a head. And the very highest grand opera; you will see and hear Patti in your own parlour. She will be heard a hundred years after her death. The President's inauguration can be treated in the same way. Pope Leo and his cardinals may be seen and heard for a hundred years to come.'

'What a way to write history!' he continued enthusiastically. 'How much more effectively one could convey to future generations an idea of the President than words and writing could! In fact, written records would cease to have their historical importance. Yet,' he added, 'these things are not so wonderful as they seem.'

CHAPTER XVIII.

ORE-MILLING, ETC.

ALMOST two years ago, in the pages of *Maclure's Magazine*, Mr E. J. Edwards gave a very interesting account of the problems which Mr Edison was then trying to solve, saying that if he succeeded he would revolutionise the iron and coal trade. This writer says: Mr Edison's most important campaign, according to his own account, upon which he has been engaged for several years, is the invention of an ore-concentrator for cheapening the process of extracting iron from earth and rock. Of ten important details necessary for success, he has mastered eight. In his own words, 'When the machinery is done as I expect to

develop it, it will be capable of handling twenty thousand tons of ore a day, with two shifts of men, five in a shift. That is to say, ten workmen, working twenty hours a day in the aggregate, will be able to take this ore, crush it, reduce the iron to cement-like proportions, extract it from the rock and earth, and make it into bricklets of pure iron, and do it so cheaply that it will command the market for magnetic iron.'

And after this iron-concentrator is finished, Mr Edison said, 'I shall turn my attention to one of the greatest problems that I have ever thought of solving, and that is, the direct control of the energy which is stored up in coal, so that it may be employed without waste, and at a very small margin of cost. Ninety per cent. of the energy that exists in coal is now lost in converting it into power. It goes off in heat through the chimneys of boiler-rooms. You perceive it when you step into a room where there is a furnace and boiler; it is also greatly wasted in the development of the latent heat which is created by the change from water to steam. Now this is an awful waste, and even a child can see that, if the waste can be saved, it will result in vastly cheapening the cost of everything which is manufactured by electric or steam power. In fact, it will vastly cheapen the cost of all the necessaries and luxuries of life, and I suppose the results would be of mightier influence upon civilisation than the development of the steam-engine and electricity have been.'

Then he went on to say that, if this waste were saved, 'it would enable an ocean steamship of twenty thousand horse-power to cross the ocean faster than any of the crack vessels now do, and require the burning of only two hundred and fifty tons of coal instead of three thousand, which are now required; so that, of course, the charges for

freight and passenger fares would be greatly reduced. It would enormously lessen the cost of manufacturing and of traffic. It would develop the electric current directly from coal, so that the cost of steam-engines and boilers would be eliminated. I have thought of this problem very much. The coal would be put into a receptacle, the agencies then applied would develop its energy and save it all, and through this energy electric power of any kind desired could be furnished. Yes, it can be done; I am sure of that. Some of the details I have already mastered, I think; at least, I am sure that I go the way to master them. I believe that I shall make this my next campaign. It may be years before it is finished, and it may not be a very long time.'

Another idea Edison had in his head at that time was marine signalling.

'I think it quite likely,' he said, 'that I may try to develop a plan for marine signalling. I have the idea already pretty well formulated in my own mind. I should use the well-known principle that water is a more perfect medium for carrying vibrations than air, and should develop instruments which may be carried upon sea-going vessels, by which they can transmit or receive, through an international code of signals, reports within a radius of, say, ten miles.'

It is interesting to note that already, in the year 1895, two special types of Edison's ore-milling machines are being used at the Ogden, N.J., mines. The machine is very successful, and is endowed with great capacity. It is a sight to look at five or six of the monster magnets extracting the metal. The upper hoppers of the machine, when filled with the ore, are opened below, and a perfect Niagara of particles, half an inch wide and thirty feet in

length, is allowed to rush past the magnets without touching them. As it rushes down, a large proportion of the ore, being magnetic, is drawn inward, changing the trajectory and showing two distinct streams, the destination of each of which is secured by separate partition boards. The clouds of dust are whirled away to specially constructed dust separators, which extract the float iron. The next process is to recrush the magnetic part which was drawn into the inner receptacle, by passing it through a series of rolls, and bringing it down to the semblance of coarse-grained gunpowder. This rough powder is then fed against the second type of magnetic ore-separator, or refining machine, inclined rows of magnets fixed firmly at a certain angle, whilst a swift travelling belt, eight feet wide and over thirty long, passes over the face of these magnets, tumbling and dashing about the mass of particles being thus cleansed, until it reaches the last magnet on the upper row, where what is left is caught up in buckets and thrown into a proper receptacle. Five thousand tons of crude ore are thus crushed and magnetically concentrated every day at the Ogden mines.

A correspondent of one of the leading Montreal papers thus graphically describes his visit to Edison at his works in New Jersey. A visit to Thomas A. Edison, he says, is suggestive of a pilgrimage to the haunts of some medieval wizard. The greatest inventor that ever lived has established himself in a dell hidden amongst verdant mountains in New Jersey wilds. Then he goes on to say the neighbourhood has no inhabitants except the two hundred men whom the Wizard employs. A somewhat shaky railroad, over which run trains, with wheezy cars meandering this way and that according as the wind blows, leads to the works at the old deserted mine once

known as Ogden, but now called after its owner, Edison. There are buildings all over Edison, great buildings which move about when a button is pressed. Indeed, we are told, the people at Edison seldom do anything without pressing a button.

No one seems to pay much attention to a visitor at Edison. Only sometimes a friendly warning is uttered, as, for instance, when a grimy unkempt worker observed calmly to the journalist, 'If you stay there another minute, you will be broken into small pieces and carried underground.'

'But can I see Mr Edison?' persisted the visitor, preparing to move on.

'I don't know,' is the careless reply. 'The old man's around somewhere. Go to that red building.'

Accordingly the visitor set off towards it, but only to find, to his chagrin, that, as he approached, it receded, stopping in the most tantalising way from time to time when he stopped, and again advancing as he drew near.

At last, however, to his satisfaction, it moved towards him, and then he found that it was an office, and, upon his pressing a button, he was informed where Mr Edison was, and that he would be along presently.

Whilst waiting for him, the journalist watched the process of 'breaking up mountains.' It begins, of course, by a button being pressed. Thereupon an immense boulder is detached from the rock, carried on a movable hod as big as a barn, dropped upon a pair of huge iron wheels, and smashed into cobble-stones.

These cobbles whirl up in the air into huge troughs or trays and come down dust, when the grains of iron contained in them are pitched out by magnets. A three-

ton boulder is broken up into fine iron in three minutes, the refuse going into the dust-hole.

At last Edison appeared. He was toil-stained, grimy, dusty, and dressed like a navvy. But his face, says the interviewer, was that of a bright, blue-eyed youth, beautifully blue-eyed and smiling. It was not until he took off his old dust-covered hat that his gray hair showed he was no longer young. Scarcely a wrinkle was to be seen on his face.

After discussing the kinetograph with his visitor, the great inventor said: 'It appears to me that the people generally are not keeping pace with scientific progress. What do you think of the idea of vaccinating land? That experiment, I see, has actually been made with success. The object of this success is to improve the quality of the soil. The law of diminishing returns, so long an important factor in political economy, is thus overcome. To explain the method employed, so as to be comprehensible to the popular mind, is not easy. You see certain roots of plants which flourish in inferior soils have been ascertained to nourish a parasite. These parasites afford the plant, through their organic functions, strength and vitality. In return the parasites are fed and sustained by certain properties of the root. One supports the other, and the two have a decided effect upon the soil in which they grow. Now this process of nature has been successfully applied by science. What we may call an agricultural miss is obtained, and the impoverished soil into which it is introduced is almost at once bettered. The process is permanently fertilising, and cannot fail to effect in time a revolution in farming.'

Here a button was pressed somewhere in the remote regions, and Mr Edison hastened away, leaving his visitor

to examine the 'Plant,' as he calls the works at Edison, which are being enlarged from day to day. It contains the only stone-breaker in the world of its extraordinary kind. It will reduce a mountain of ordinary size to dust in one day. There are telephones everywhere, and phonographs for making memoranda connected with the desks. There are no houses, no candles or lanterns. Labour is reduced to a minimum. 'A day's toil consists largely in pressing a series of buttons. And they never think this extraordinary in the queer place. Even the 'prentice boys are very scientific. They release the giant forces of nature, and hold them in check again. Edison is the Nimrod of this electrical game reserve, with his pack running and gamboling all about him.'

Having accomplished so much, Edison is still endeavouring to achieve yet greater things. Mr Lenier tells us, as did Mr Edwards, that he is working at a still harder problem—so it seems to me—than any he has yet solved. It is the direct production of electricity from oxygen and coal (carbon). At present we burn coal to obtain steam, which is transmuted into mechanical energy, and thence into electricity. Under the very best conditions, before the energy of the coal reaches the dynamo, six-sevenths of its power are lost. If a way is found to dispense with the steam-engine in the making of electricity, the mechanical energy of the world will be multiplied seven times. Many of the cleverest and most earnest engineers and chemists are now striving—mostly in secret—to obtain this great result. Edison confidently predicts that the discovery will come.

When this immense saving of fuel has been effected, the great Atlantic steamers will only need a coal-bin which will hold two hundred and fifty tons of coal, instead of one for

three thousand, to carry them across the Atlantic. Much greater speed will then be attained, and far less expense to the public will be the pleasing result.

Edison does not believe in the necessity for capital punishment. 'There are wonderful possibilities in each human soul,' he says, 'and I cannot endure a method of punishment which destroys the last chance of usefulness.'

But, notwithstanding this, he has been induced to make many experiments, with a view to cutting off the lives of criminals who would otherwise be hanged, by the more merciful and rapid death from electricity. As usual, success has crowned his endeavours, and 'electrocution' is steadily winning precedence as the least objectionable form of judicial killing.

CHAPTER XIX.

CONCLUSION—EDISON'S PRESENT SURROUNDINGS.

ESIDES his large establishments at Orange, N.J., Edison has also a smaller place at Fort Meyers, Florida, where he is supposed to go for recreation, although even there he cannot leave his work behind, and so has a small but complete laboratory attached to it.

In the roomy and pleasantly situated house, and large, undulating gardens, studded with tropical palms and rich in all kinds of flowering plants, Edison's father, Mr Samuel Edison, and Mr James Symington, a friend of thirty-seven years, spend a large portion of their time. Mr Edison, senior, is ninety years of age, but hale and well in mind and body. He delights in gardening, and is to be seen

busy at work early in the morning and through the hottest hours of the day.

Edison's biographers tell us that, on one of his visits to Fort Meyers, Edison offered to supply the town with a system of electric lighting, if the Meyerites would furnish the poles. This generous offer, which any other corporation with a modicum of sense would have been only too pleased to accept, was languidly refused by the inhabitants of the place.

Far and wide as the electric light has extended, there are in many other places besides Fort Meyers sundry influences which tend to keep it back. Speaking of those at present prevailing in Europe, Edison said to a recent interviewer: 'I think the gas interests have still a lease of life. In my opinion those who have had the making of the laws and regulations relating to the electric lighting industry, perhaps guided by the supply companies themselves, have managed to get it off the right track, and now nearly all the operating companies are on a wrong business basis for any rapid development. Nowadays the chief concern of the station manager is to grind out as much current as possible for every pound of coal he burns. He gets economical boilers, engines, and generators, and studies their arrangement. These are so near the practical limits of their perfection that only a two or three per cent. improvement can be expected; and so long as the station has a fair load, shows a good efficiency, and does not have breakdowns, every one appears satisfied. The consumer grumbles at the cost of electric lighting, but pays his bill; the shareholder pockets his small dividend, and the manager is happy. They are selling current by Board of Trade units, although in competition with gas; it is light the public wants, not ampères. Let them produce

more light—more candle-power—per horse-power hour. I will grant the difficulty of fixing a "unit of light," but it is not necessary to do so; it is an easy matter to charge from the meter indications for the lamp hours delivered. If the station simply receives payments for volts delivered, it has no inducement to increase the efficiency of the lamp. The companies will even frown upon the inventor, or lamp manufacturer, who gives the consumers lamps taking half as much current, because that lessens their demand and the total consumption; in fact, it is to the station's interest to see lamps chewing as much current as the poor consumer will pay for. At the same time lamp improvements are kept back because the efficient lamp is a short-lived one, and to educate the vast public to study their meter bills instead of their lamp bills is a slow and tedious process. To an ordinary householder each thirty cents spent on a lamp is an evident out-of-pocket expenditure. His main idea is to get the lamp that requires replacement least often. Who is to blame,' he asked, 'the business man or the professor, for the conditions you can find in London of an alternating plant occupying a certain confined area, in which the copper put down in the transformers alone, leaving out any distributing wire, is over and above ample to give a complete and magnificent system of distribution, had a complete low-tension system been employed instead? Was it not lack of unity? With regard to the direct low-tension system, Mr Edison declared that he had not changed his opinion one iota. Alternating systems may have their field—they are explorative—and perhaps a necessary development just now; but the cream of the electrical business is in the large towns, and I believe all these centres can be best supplied with direct low-tension three-wire systems. With the present one-

hundred-volt lamp we are able to give service within one mile radius, or say over an area of four square miles. The largest town would not want many such stations.'

Edison's magnificent northern home is Glenmont, in New Jersey. It consists of an extensive and superbly appointed house, which, built of brick, stone, and wood, abounds in gabled roofs, picturesque nooks and angles, carved balconies, and richly hued stained-glass windows. Beautiful grounds, fitted up with rare shrubs and much that can delight the eye, surround this spacious building.

Edison married a second time, a beautiful young girl, who has borne him two little ones, Madeline and Charles. They and his elder children—the elder boy is learning to be an inventor in his father's laboratory—have at Glenmont a beautiful and stately home.

There, with all that wealth can buy to make life enjoyable, it is pleasant to think of this hard-working man, who began his career under such great disadvantages as a poor newspaper-boy, and worked his way up the ladder of fame as bravely and steadily as any man on earth, resting sometimes, and enjoying the happiness of his dear ones, as he lavishly bestows upon them the treasures won by almost superhuman efforts.

At beautiful Glenmont, on the occasion of a juvenile party being given in honour of Edison's daughter Madeline, the great electrician gave a brilliant display of his electric light.

Many incandescent bulbs stained in a variety of exquisite colours were hidden amongst the crystal fringes and stalactites of the great chandeliers, and so connected with the sources of electrical supply as to throw out divers sheets of ruby, sapphire, amethyst, and gold, in a manner like the illumination of St Peter's at Rome. In the life-cake, a

brilliantly sparkling structure of fairy towers and chatelaines, foliage and frosted bloom, a single electric bulb was placed, which glowed like a sea of light in a setting of minor gems made of a fringe of tiny incandescent lamps not much larger than drops of dew.

Edison's biographers graphically describe their visit to him at Glenmont. Upon arriving there, after mounting some steps they were shown into a luxuriously furnished entrance-hall, which seemed to serve as a general lounging-place for the whole family. There was a huge old-fashioned fireplace, heaped up with logs and provided with large andirons. The windows in the hall and on the grand staircase were of richly-coloured glass. Passing up this staircase, which was of polished mahogany, the visitors went into the dining-room, 'rich with carvings of oak and mahogany, hunting and pastoral scenes,' and on to Mr Edison's private sitting-room at the other side.

The great man was sitting in a deep armchair. His deafness was worse than usual that day, as he was not feeling well, and had been taking quinine—which was bad for his hearing—so he did not know visitors were in the room until he was aroused to receive them. Then he looked round from behind a New York periodical, with a face illumined with good-nature and kindly feeling, and greeted them warmly. They felt the pathos of the situation, as they said afterwards, in thus finding the man 'to whom we owe such an immeasurable debt in the extension of our physical powers, thus patiently enduring the isolation of his soundless prison.' Apropos of this, it is good to hear from a more recent visitor that Mr Edison's hearing has improved during the past year, owing perhaps to his perfect physical condition.

His room seemed to be a favourite resort of the whole

family, whose tastes were shown in several ways. There was a Weber piano of much sweetness, an organette or mechanical organ, a magic lantern, a phonograph, and several revolving bookcases well filled with scientific works. On the mantel-piece were ornaments which were gifts from the Emperor of Russia, the Society of Engineers in Japan, and so on.

Mrs Edison, 'her queenly head crowned with an aureole of nut-brown hair,' and clad in a gown of pearl and silver draperies which well showed her pretty figure, graciously pointed out to the visitors her husband's medals and decorations. Amongst these were the Prince Albert gold medal from the London Society of Arts, the three degrees of the Legion of Honour—officer, chevalier, and commander—the bronze medal of the Photographic Society of France given to him because of his kinetograph, the order of the Commander of the Crown of Italy, and medals from Boston and New York Institutes, and from the exhibitions of Sydney, Melbourne, Milan, the Crystal Palace, and Paris.

In an interesting scrap-book are many autographic letters of great interest, amongst which is the record of a message from the Queen of Italy, phonographically received by Mr Edison, on the occasion of his visiting Europe with Mrs Edison for the purpose of going to the Paris Exhibition in 1889. It contains the words: 'Women everywhere owe to Mr Edison a deep debt of gratitude for giving them the means of bringing near to them the very voices of loved ones who are far away.'

It was on the occasion of that visit to Paris that Madame Carnot placed the presidential opera box 'at Monsieur and Madame Edison's disposal,' and the reception accorded to them at the opera was most enthusiastic.

Three boxes had been thrown into one, the house was hung with American flags and national colours, and as the Edisons entered, the orchestra struck up the national anthem of America. As soon as the opera was over, the audience hastily left the place; and when the Edisons reached the brilliantly lighted boulevard, they were surrounded with a great crowd shouting, 'Vive Edison!'

After this brief glimpse of the adulation paid to successful genius by the denizens of the Parisian world, Edison returned to America, to his beautiful home and to his hard-working life in his great laboratories.

Mr Edwards tells us that when Edison was congratulated upon attaining his forty-sixth birthday, he said that he did not measure his life by years, but by achievements or by campaigns, and that he looked forward to no period of rest, believing that, for him at least, the happiest life is a life of work.

And in speaking of his campaigns, he remarked: 'I do not regard myself as a pure scientist, as so many persons have insisted that I am. I do not search for the laws of nature, and have made no great discoveries of such laws. I do not study science as Newton, and Kepler, and Faraday, and Henry studied it, simply for the purpose of learning truth. I am only a professional inventor. My studies and experiments have been conducted entirely with the object of inventing that which will have commercial utility. I suppose I might be called a scientific inventor, as distinguished from a mechanical inventor, although really there is no distinction.'

Speaking of the campaigns and achievements by which he measured his life, the great electrician mentioned first the stock-ticker and the telephone, upon the latter of which he had worked very hard, but said he looked upon the phono-

graph as the greatest of his achievements in the early part of his career. 'That,' he said, 'was an invention pure and simple. No suggestion of it, so far as I know, had ever been made; and it was a discovery made by accident, while experimenting upon another invention, that led to the development of the phonograph.' Then he went on to say that the second campaign was the invention of his incandescent lamp, which, as we have seen, was the first lamp of the kind which became commercially valuable. He worked about three years upon that, he said, and some of his experiments were very delicate and very costly. That, he estimated, had been so far his chief achievement, as it certainly was the first one which made him independent and left him free to begin other campaigns without the necessity of calling in outside capital, or of finding his invention subject to the manipulations of Wall Street. 'I am now fortunate enough,' he continued, 'to have capital of my own, and that I shall use in these campaigns' (his campaigns in the future).

People who are not Christians are fond of asserting that the scientific mind is opposed to belief in God. But Edison is a direct refutation of this.

One day, when he was talking to Mr Lathrop, he said, 'I do not believe that matter is inert, acted upon by an outside force. To me it seems that every atom is possessed by a certain amount of primitive intelligence. Look at the thousand ways in which atoms of hydrogen combine with those of other elements, forming the most diverse substances. Do you mean to say that they do this without intelligence? Atoms in harmonious and useful relation assume beautiful or interesting shapes and colours, or give forth a pleasant perfume, as if expressing their satisfaction.'

'But where does this intelligence come from?' he was asked.

The answer was ready: 'From some power greater than ourselves.'

Then the other asked, 'Do you believe, then, in an intelligent Creator, a personal God?'

'Certainly,' replied Edison; 'the existence of such a God can, to my mind, almost be proved from chemistry.'

Mr Edwards reports also that he said to him, 'I tell you that no person can be brought into close contact with the mysteries of nature, or make a study of chemistry, without being convinced that behind it all there is supreme intelligence. I am convinced of that, and I think that I could, perhaps I may sometime demonstrate, the existence of such intelligence through the operation of those mysterious laws with the certainty of a demonstration in mathematics.'

It is a fitting thing that he to whom the Almighty has vouchsafed such great gifts of power and knowledge, gifts which bear fruit oftentimes so like the ancient miracles, should thus bear witness to the One greater than himself, who alone creates and disposes of every creature, animate or inanimate, in his whole world.

And here we must leave Edison. Marvellous as have been his achievements in the past, the future is for him bright with possibilities. He himself has said, 'I think the world is on the eve of grand and immense discoveries, before whose transcendant glories the record of the past will fade into insignificance.'

THE END.

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